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WIDOWAC (WING DESIGN OPTIMIZATION WITH AEROELASTIC CONSTRAINTS): PROGRAM MANUAL

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16. Abstract

User and programer documentation for the WIDOWAC programs is given. WIDOWAC may be used for the design of minimum mass wing structures subjected to flutter, strength, and minimum gage constraints. The wing structure is modeled by finite elements, flutter conditions may be both subsonic and supersonic, and mathematical programing methods are used for the optimization procedure.

The user documentation gives general directions on how the programs may be used and describes their limitations; in addition, program input and output are described, and example problems are presented. A discussion of computational algorithms and flow charts of the WIDOWAC programs and major subroutines is also given.

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CONTENTS

Page

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SUMMARY

User and programer documentation for the WIDOWAC (WIng Design Optimization With Aeroelastic Constraints) programs is given. WIDOWAC may be used for the design of minimum mass wing structures subjected to flutter, strength, and minimum gage constraints. The wing structure is modeled by finite elements, flutter conditions may be both subsonic and supersonic, and mathematical programing methods are used for the optimization procedure.

This program manual gives general directions on how the programs may be used and describes their limitations; in addition, program input and output are described, and example problems are presented. A discussion of computational algorithms and flow charts of the WIDOWAC programs and major subroutines is also given.

INTRODUCTION

The WIDOWAC (WIng Design Optimization With Aeroelastic Constraints) computer programs were developed for the design of minimum mass wing structures subjected to flutter, strength, and minimum gage constraints. The methods used in WIDOWAC are discussed in reference 1. The wing structure is modeled by finite elements, flutter conditions may be both subsonic and supersonic, and mathematical programing methods are used for the optimization procedure.

The present paper contains the user and programer documentation for WIDOWAC. User documentation gives general directions on how the programs may be used and their limitations, defines program input and output, and presents example problems. A discussion of the computational algorithms and flow charts of the WIDOWAC programs and major subroutines are given as programer documentation in the appendixes A to F.

In addition to the program documentation provided, WIDOWAC itself contains many comment cards to help the user. Comment cards in the beginning of WIDOWAC include a

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definition of the input and a dictionary of variable names. In addition, each subroutine in WIDOWAC contains comment cards which clarify the purpose of the subroutine and the methods used in it.

SYMBOLS

Values are given in both SI and U.S. Customary Units. Calculations were made in U.S. Customary Units.

A,a	speed of sound
b_o	root semichord
C(I)	ith design variable
CSAV	vector of current values of design variables
CTEST	ratio of penalty function to object function
c_i	generalized coordinate
DELH	altitude increment
DELOM	flutter frequency increment
DELV	flutter speed increment
GAMA	ratio of specific heats
G(I),g_i	ith constraint term
g	artificial damping parameter
g_s	structural damping coefficient
H	altitude
H_F	normalizing altitude

H_f	flutter altitude
$H_{f,cr}$	critical flutter altitude
HINIT	initial altitude
h	airfoil local depth
IGAIN	ratio of number of entries in V,g table to NK
IOPT	program operation control parameter
IPRINT	print control parameter
IZCOR	z coordinate input parameter
KFK	aerodynamic speed regime parameter
KMAX	maximum reduced frequency
KMED	median reduced frequency
KMIN	minimum reduced frequency
LUNIT	length scale factor
ℓ	semispan
M,MACH	Mach number
MNORM	scale factor for tuning masses
MUNIT	mass scale factor
NDV,NC	number of design variables
NEIG	number of vibration modes for flutter analysis
NEL,n_{el}	number of finite elements

NF	number of flutter conditions
NFREE	number of rigid body modes
NK	number of reduced frequencies
NMAT	number of materials
NNOD	number of nodes
NOC	number of constrained nodes
NRR	array of nodal constraints
NS	number of x points per y station used for collocation
NTSEG	number of segments
NVEC	number of eigenvectors used in solution procedure for determining natural modes
NXP	maximum number of x points per y station for aerodynamics grid
NYC	number of y stations used for collocation
NYS	number of y stations for aerodynamic grid
n_{con}	number of constraints
OMINIT	initial value of flutter frequency
PF	penalty function
PFUNC	object function
Q	quadratic convergence error prediction
q	dynamic pressure

R,r	penalty function coefficient
RDC	reduction factor for R after each minimization
RHOA	air density
S	length of move in one-dimensional direction
SG	structural damping coefficient
SR	stress ratio
s	ratio of semispan to root semichord (appendix D)
s_1,s_2,s_{12}	allowable stresses
T_i,TUL(I)	scale factor for ith constraint
TWT	total structural mass
V	speed
V_f	flutter speed
$V_{f,cr}$,VCR	critical flutter speed
VFIN	final value of flutter speed for an analysis
VINIT	initial value of flutter speed
$\bar{v}$	vector of design variables
v_i	ith design variable
WT	mass of variable structure
x	streamwise direction
y	spanwise coordinate

z	coordinate normal to x,y plane
z^k	z displacement associated with kth mode
Δp^i	pressure differential associated with ith mode
ρ	air density
$\sigma_1,\sigma_2,\sigma_{12}$	stresses
ω	flutter frequency
ω_i	ith natural frequency

BASIC INFORMATION

General Description

The computer programs WIDOWAC are intended to perform the design function of sizing a minimum mass wing structure subjected to a single static load condition and multiple flutter conditions. The programs can also perform stress, vibration, and flutter analyses of a specified wing (without resizing).

The wing structure is modeled with membrane finite elements for the cover panels, and rod and shear web elements for ribs and spars. The structural model is assumed to have no camber or twist. The thickness of planar elements, areas of rod elements, and the magnitude of tuning masses[2] are used as design variables; some design variable linking is available. The effect of static aeroelastic deformations on design load distribution is not considered in the stress calculation. Static loads are specified by the user in the input data deck.

Kernel function aerodynamics is used for the subsonic flutter calculations, and second-order piston theory aerodynamics is used for the supersonic flutter calculations. Divergence is treated as a special case of flutter. An interior penalty function formulation using Newton's method for optimization provides the resizing capability.

WIDOWAC consists of three separate programs. The first program CONMAN reads and processes the input data, and the second program EXEMAN performs the analysis or optimization. In addition, a third program SUBKRN generates the subsonic kernel function

[2]Tuning masses are concentrated masses attached to the structure to improve flutter characteristics.

aerodynamic matrices when they are required. The programs use dynamic storage allocation for problem-dependent array sizes so that there are no hard limits on the number of degrees of freedom or finite elements. Practical limits as dictated by both core storage and run times are of the order of 200 to 300 degrees of freedom and 20 to 30 design variables.

Coordinate System and Units

It is assumed in WIDOWAC that the wing midsurface is in the x,y plane; x is the coordinate in the stream direction, positive aft, and y is the spanwise coordinate, positive in the outboard direction to the right. The z coordinate is positive upward. (See fig. 1.)

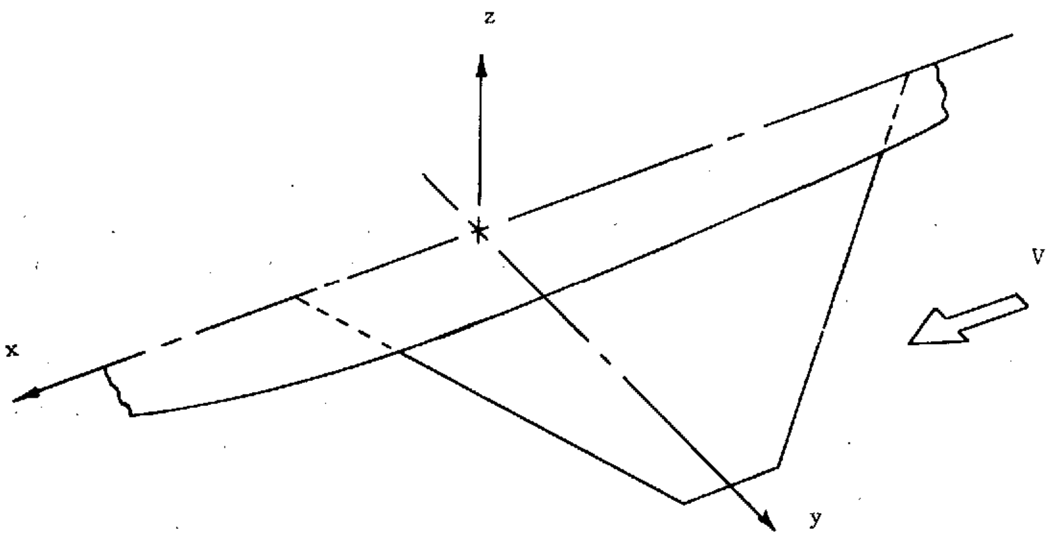

Figure 1.- Coordinate system.

The time unit in WIDOWAC is the second. Other units are arbitrary, but consistent,[3] except for altitudes which must be in meters because of the standard altitude tables used by the program. All units are dimensional, except for the aerodynamic grid which is in terms of nondimensional coordinates to be discussed in a subsequent section.

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[3]The term consistent implies, for example, that if the length unit for the structure is the inch, and the force unit is the pound, then speeds must be in in/sec and masses in lb-sec^2/in.

Structural Model

The structural model used in WIDOWAC is based on a wing without camber or twist and the following assumptions concerning the deformations are made:

(1) There is no relative z motion between corresponding points (that is, points having the same x,y coordinates) on the lower and upper surfaces of the wing.

(2) The x,y displacements of a point on the upper wing surface are equal in magnitude and opposite in sign to those of the corresponding point on the lower wing surface (that is, pure bending).

Because of these assumptions, only nodes on the upper wing surface are included in the structural model. The shear web used in WIDOWAC (ref. 1) is defined by two nodes on the upper wing surface. The other two nodes are assumed to be the corresponding points on the wing middle surface. The constraints embodied in the assumptions on the motion of the upper and lower wing surfaces are built into the shear web element; thus, these constraints are automatically accounted for.

In addition to the shear web element, the following finite elements are available in WIDOWAC and are essentially the same as the corresponding NASTRAN elements (ref. 2):

(1) Rod element (CROD in NASTRAN)

(2) Triangular constant strain membrane element (CTRMEM in NASTRAN)

(3) Quadrilateral element (CQDMEM in NASTRAN) which is formed from two sets of triangular constant strain elements. One set of two triangles is formed by using one diagonal, and the other is formed by using the other diagonal.

The only constraints that may be applied to the wing structure are single point constraints specifying that a given displacement component is zero (see section "Boundary Condition Data Deck"). The WIDOWAC programs can be used to analyze a wing having rigid-body degrees of freedom, but the user must add the minimum number of dummy constraints[4] that are required to constrain the wing fully. The external loads in this case must be self-equilibrating so that the dummy constraints do not have any effect on the stress distribution. For the calculation of vibration modes, the rigid-body motion is specified by the user in the form of rigid-body modes. The elastic modes are then constrained to be orthogonal to the rigid-body modes with respect to the mass matrix.

The mass matrix used in the finite-element model is based on lumped masses and must be positive definite. As a consequence, each node must have nonzero mass either in the form of structural mass or in the form of nonstructural mass.

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[4]Note that insofar as the input is concerned, there is no difference between dummy and real constraints.

Design Variables and Segments

WIDOWAC may be used to minimize total mass by optimizing the thickness of the structural elements and the magnitude of tuning masses. The design variable definition is established by identifying some structural thickness or nonstructural mass with a design variable number. Once this identification is made, the incremental thickness above minimum gage or the mass will have the value given to the design variable.

The use of mathematical programing for the optimization procedure limits the number of design variables that may be used with reasonable computation times. Thus, for many problems it is not practical to associate a separate design variable with the thickness of each finite element. In WIDOWAC, it is possible to assign the same design variable to more than one element thickness. It is also possible to divide part of or all the wing skin into segments containing one or more elements with linear variation of incremental thickness within each element. Thus, a single design variable may control the thickness of a single element, a group of elements, or the vertex of a segment. Note that the segment type of thickness definition is available only for the skin-membrane finite elements but not for the shear-web or rod finite elements.[5] Note also that parts of the structure may be assigned no design variables; thus, they remain unchanged during the optimization process.

A typical example of the use of segments is shown in figure 2. The wing is divided into six segments, each consisting of a few finite elements. Design variables are assigned to the thickness of the vertices of the segments. If the segment is triangular, its thickness variation is assumed to be linear. A quadrilateral segment is divided into two triangles and the thickness is assumed to be linear in each triangle for the purpose of calculating the thickness at the nodes.

The thickness of each finite element in a segment is assumed to be the average of the thickness at its nodes. It is possible to assign the same design variable to more than one vertex; thus, further constraints may be imposed on the thickness variation. Assigning design variables to individual elements in a segment (unless the segment contains only one element) is not allowed.

Some elements or segments have thicknesses which are completely fixed (invariant), and others have thicknesses which are composed of a fixed part and an incremental part which is controlled by the design variables. The same holds for the nodal masses. Part of the mass at a node is associated with the fixed part of the structure, part of the mass is associated with the thickness which is controlled by design variables, and at some nodes there is additional mass due to the tuning masses which are controlled by design variables.

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[5] For rod elements it is the cross-sectional area rather than the thickness that is the design variable.

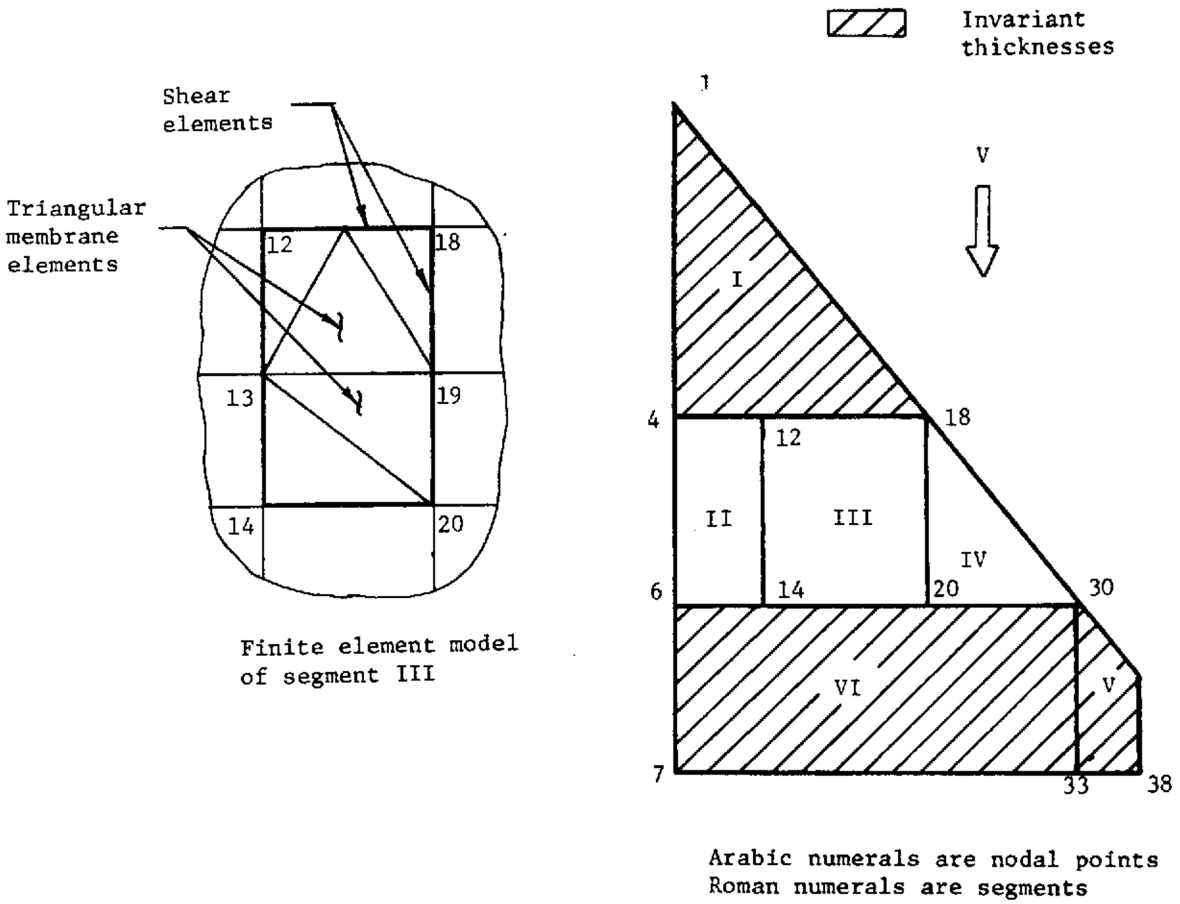


Figure 2.- Typical model for defining design variables.

The thickness of elements input in the element data deck, the thickness of the segment vertices input in the segment data deck, and the masses input in the mass data deck (see sections on these data decks) define the fixed part of the structure. The controlled part of thicknesses and masses is defined by the user by identifying thicknesses and masses with design variables and assigning values to these design variables. Design variables may not be negative so that the part of the structure defined by specifying element and segment thicknesses is the minimum gage structure. The total thickness of any element is always the sum of its minimum gage thickness plus the additional part defined by the design variable, if any, which controls the thickness of that element. (Note that a design variable may control the thickness of the element indirectly by defining the thickness at the vertex of the segment in which the element is located.) The segment thickness data override the element thickness data, except when the thicknesses of all segment vertices are set to a value of -1. Thus, it is possible to define the minimum gage in a segment of the wing by using element data and the optimization procedure increments the thickness by using segment data.

Flutter Calculations

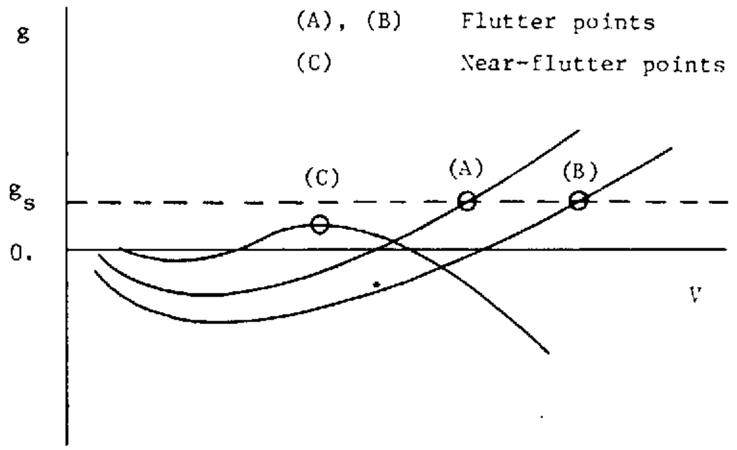
The flutter problem is solved by using the vibration modes of the structure as generalized coordinates. The calculation of the vibration modes is done by simultaneous mode iteration (ref. 3) and is controlled by the user through the two parameters NEIG and NVEC (namelist DIMNSHN). NEIG is the number of vibration modes needed for the flutter analysis and NVEC is a larger number of modes used during the iteration process to accelerate the convergence of the vibration modes. The optimum ratio of NVEC to NEIG is problem dependent, but NVEC = 1.5 NEIG is usually reasonable. The vibration modes are orthogonal (with respect to the mass matrix) to the rigid body modes, if any.

Any number of subsonic or supersonic flutter conditions (for example, different Mach numbers or altitudes) may be specified and divergence is treated as a special case of flutter at zero frequency. The general procedure in using WIDOWAC for flutter calculations is to perform an analysis run in order to establish the lowest flutter point for a given wing. If the wing is to be resized so that a flutter constraint is satisfied, the flutter point obtained from the original flutter analysis is used as the initial flutter point for the optimization run. Note that the starting point must satisfy the flutter constraint. After the optimized structure has been determined, an additional analysis run should be performed for the optimized design to insure that a lower flutter point does not exist for the wing. The program's input and output for each flutter condition depends on whether it is an optimization run or an analysis run, and also whether it is a subsonic or supersonic flutter condition.

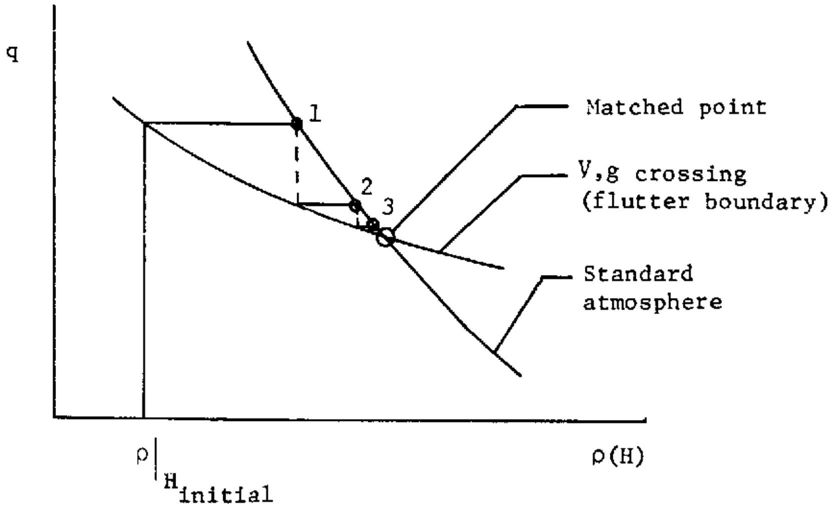
Subsonic flutter conditions.- For subsonic flutter conditions, the flutter analysis is for a constant Mach number which is specified by the user. Program EXEMAN requires the aerodynamic matrices generated by the subsonic kernel function program, program SUBKRN. The input to this program (see section "Namelist NAM1") includes the Mach number and the number and range of the reduced frequencies for which these aerodynamic matrices are calculated. The aerodynamic matrices are put on a disk file called TAPE17 unless the user intervenes through a control card (see section "Control Cards and Job Organization") and may be saved for later use. When more than one subsonic condition is imposed, it is necessary to put at least one set of aerodynamic matrices on a file different from TAPE17. Program SUBKRN need not be executed if the aerodynamic matrices for all Mach numbers and reduced frequencies are already available from previous runs and are stored on a permanent storage device such as a magnetic tape.

Analysis run: For a subsonic flutter analysis run, the program generates V,g tables for three altitudes and finds the matched flutter point (ref. 4) at which speed, altitude, and Mach number are consistent with the standard atmosphere. The procedure is as follows: The first altitude is specified by the user (HINIT in namelist FLUTER). The lowest flutter speed (that is, lowest speed when the required structural damping becomes larger than the user-specified critical damping g_s (fig. 3(a)) is found by linear

interpolation from the V,g tables. Generally, this flutter point is not a matched point. The program seeks the matched point by looking for a second altitude in the standard atmosphere by assuming that the dynamic pressure is constant and equal to that of the flutter solution found for the initial altitude. This process is repeated twice more so that the V,g tables are generated for three altitudes. (See fig. 3(b).) Usually, if the initial altitude is within 15 000 meters from the matched altitude, the altitude and frequency predicted by the last V,g table would be good enough to start the optimization process.



(a) V,g diagram.



(b) Matched-point calculation. M = Constant; $q = \frac{1}{2}\rho V^2 = \frac{1}{2}\rho M^2 a^2$.

Figure 3.- Calculation of a matched flutter point.

The values of the reduced frequency for which the V,g points are calculated depend on the parameters KMAX, KMED, KMIN, NK, and IGAIN in namelist FLUTER. The first four parameters define the reduced frequencies for which the aerodynamic matrices are calculated (or are available). The generalized aerodynamic forces for additional values of the reduced frequency are interpolated from the NK values which are calculated from the aerodynamic matrices.

Optimization run: For a subsonic flutter optimization run, the program requires a close initial estimate of the altitude (HINIT) and the frequency (OMINIT) at the flutter point. Such estimates may be obtained by first running WIDOWAC in the analysis mode. (See previous section.) The program seeks the exact matched point by using Newton-Raphson iteration to drive the complex determinant of the flutter equations to zero by varying the frequency and altitude. As the structure is being changed, the program seeks a new flutter point in the vicinity of the previous point. The user should be aware of the danger of mode switching which might cause an additional flutter mode to appear at a lower speed during the design process. Thus, although in figure 3(a) the lowest flutter crossing is point (A), it is possible that as the structure is changed, the crossing (B) may move to the left and become the critical condition. The user may guard against the mode (B) flutter speed becoming lower than the specified speed by assigning to crossing (B) another flutter constraint (that is, have two flutter constraints at the same Mach number). It is not possible in WIDOWAC to guard against the mode (C) becoming critical, and it is recommended that the final design be reanalyzed to check that such mode switching has not occurred.

Supersonic flutter conditions.- For supersonic flutter conditions the flutter calculations are performed at a constant altitude defined by the user by specifying the values of the air density, speed of sound, and specific heat ratio. The aerodynamic matrices are calculated in program EXEMAN in this case so there is no need for any file handling as in a subsonic case. The Mach number appears explicitly in the formula for the matrices so there is no problem of a matched point for a supersonic flutter condition.

Analysis run: For an analysis run the user specifies a grid of values of speeds and frequencies and the program calculates the flutter determinant at the points of this grid. The user must look for a simultaneous change in the signs of the real and imaginary parts of the flutter determinant to locate a flutter point.

Optimization run: For an optimization run the program requires a close initial estimate of the speed (VINIT) and the frequency (OMINIT) at the flutter point rather than altitude and frequency as in the subsonic case. Such estimates may be obtained by first running WIDOWAC in the analysis mode. (See previous section.) The optimization process is the same as in the subsonic case except that the frequency and speed are varied rather than the frequency and altitude.

Aerodynamic Grid

The natural vibration modes of the wing are used in WIDOWAC as generalized coordinates for the flutter equation. These modes are calculated by using a finite-element model of the structure and, therefore, are available directly only at the nodes of that structural mode. For the calculation of the generalized aerodynamic forces, the deflection and streamwise slopes of the natural vibration modes are needed at sets of integration and collocation points which generally do not coincide with the structural nodes. The modes are evaluated at these points by interpolation. In WIDOWAC, only one-dimensional spline interpolation along chord lines is available and, therefore, enough structural nodes should be located along streamwise lines to make such interpolation possible. The user defines the subset of the structural nodes which is to be used for interpolation by defining the chords on which these nodes lie and the node numbers. (See section "Aerodynamic Grid Data Deck".) All the chords defined by the user are used by the program for integration of the generalized aerodynamic forces. Integration points along these chords are chosen by the program. The user specifies both the subset of the chords and the number of collocation points along each chord to be used in the solution of the subsonic downwash-pressure integral equation. The number of chords is equal to the number of spanwise pressure functions and the number of collocation points along a chord is equal to the number of chordwise pressure functions. The choice of chords and number of collocation points is a matter of experience and is problem dependent. It is suggested that for new problems, these parameters should be varied to check convergence. Run time for optimization under subsonic flutter constraints is sensitive to the number of collocation points and this number should be kept to a minimum.

Optimization Method

WIDOWAC uses the Sequence of Unconstrained Minimization Technique (SUMT) with an interior penalty function accounting for the constraints. The optimization problem is to minimize the mass W subject to the constraints

$$g_i(\bar{v}) \geqq 0 \qquad \left(i = 1(1)n_{con}\right)$$

where $\bar{v}$ represents the vector of design variables, g_i is the ith constraint and n_{con} is the number of constraints. This constrained optimization problem is transformed into the following series of unconstrained problems: Minimize

$$f = W + r \sum_{i=1}^{n_{con}} \frac{T_i}{g_i}$$

for $r = r_1, r_2, r_3, \ldots, r_n \rightarrow 0$. The sum which is added to the mass is called the penalty

function and it is composed of individual constraint penalty terms T_i/g_i where the T_i are arbitrary factors. For large values of r, the minimum of f is well away from all constraints, and as r is made smaller, the minimum of f approaches some of the constraints. The penalty terms act as "padding" over the constraints and lessen the chance of the design converging into a corner which represents only a local minimum. For each value of r the unconstrained minimization is performed by using Newton's method with approximate derivatives used for generating a search direction and a one-dimensional search is then used for locating the minimum in that direction. The minimization for a single value of r is terminated when any one of the following criteria is satisfied:

(1) The Euclidean norm of the gradient vector, calculated by forward finite differences, of the object function is reduced by a factor of 20 from its initial value (gradient convergence).

(2) The program estimates that the last one-dimensional search was initially less than 2 percent from the minimum (quadratic convergence).

(3) Five one-dimensional searches have been executed.

The user has control over the optimization procedure by specifying the values of r and T_i (R and TUL(I) in namelist OPTIMUM, respectively) and the factor RDC (namelist OPTIMUM) which is used to reduce R after each one of the unconstrained minimizations. The combination of a large value of R and a small value of RDC keeps the search away from the constraints longer and thus lessens the chance of converging to a local minimum, but increases the run time. A rule of thumb often used is to pick a value of R which makes the penalty function roughly equal to the mass for the initial design.

The output of WIDOWAC includes the values of g_i for the constraints. The smallest g_i values are the ones the program determines to be the most critical. The user has control over the relative importance of each constraint by specifying different values of T_i.

Constraints.- Three types of constraints may be imposed in WIDOWAC: stress, flutter, and minimum gage constraints. The stress constraints are based on Hill's criterion. (See ref. 5, p. 26.) The stress constraint g_{st} is

$$g_{st} = 1 - SR \geqq 0$$

where the stress ratio SR is defined as

$$SR^2 = \left(\frac{\sigma_1}{s_1}\right)^2 - \frac{\sigma_1}{s_1}\frac{\sigma_2}{s_1} + \left(\frac{\sigma_2}{s_2}\right)^2 + \left(\frac{\sigma_{12}}{s_{12}}\right)^2$$

where σ_1, σ_2, and σ_{12} are the stresses and s_1, s_2, and s_{12} are the corresponding allowable stresses. The stress constraint is applied to each element individually; but for

the purposes of printout and performing a one-dimensional search, it is summed over all elements and lumped as

$$\tilde{g}_{st} = \left(\frac{1}{n_{el}} \sum_{i=1}^{n_{el}} \frac{1}{g_{st,i}} \right)^{-1} \geqq 0$$

where i denotes element i, n_{el} is the number of elements, and $\tilde{g}_{st}$ is the lumped stress constraint.

Either subsonic or supersonic flutter constraints may be applied. For a supersonic flutter condition the constraint is that the flutter speed V_f must be above a critical value $V_{f,cr}$; that is,

$$g_{f,i} = 1 - \left(\frac{V_{f,cr}}{V_f} \right)_i \geqq 0$$

where i denotes the ith flutter condition (assumed to be supersonic). For a subsonic flutter condition the constraint is that the flutter altitude H_f must be below a critical value $H_{f,cr}$; that is,

$$g_{f,i} = 1 - \left(\frac{H_f - H_F}{H_{f,cr} - H_F} \right)_i$$

where H_F is a normalizing (floor) altitude (usually a large negative value) so that $H_f > H_F$ all through the design process.

The minimum gage constraint requires that the design variables be positive. This condition implies that the structure obtained when all the design variables are equal to zero is the minimum gage structure.

PROGRAM COMPUTER DETAILS

Machine Requirements

The WIDOWAC programs are written for the Control Data Corporation (CDC) 6000 series computers. The programs run under the Control Data Corporation SCOPE system (NASA Langley Research Center version). Most of the programing is written in FORTRAN IV; however, some special-purpose subroutines are written in COMPASS. These subroutines include comment cards which describe how they may be converted to FORTRAN.

Storage Allocation

For execution, the WIDOWAC programs require a minimum of 60 000 octal storage on the CDC operating system. The actual storage requirements for the arrays in programs CONMAN and EXEMAN are printed out by the programs as the amount of blank common which is required. The total field length is the first address of the blank common plus the blank common requirement. Since the field length is problem dependent, the user has to estimate the required field length for any new problem that he runs. An approximate formula (in octal) for the field length required for an analysis run (no design variables) is

$$FL_8 = 62000_8 + \left[11\ \text{NEL} + \text{NNOD}(72 + 1.5\ \text{NNOD})\right]_8$$

where NEL is the number of finite elements and NNOD is the number of nodes. For an optimization run, the additional field length is approximately

$$\Delta FL_8 = \left[\text{NEL}(1 + \text{NDV}) + \text{NNOD}^2\left(1 + \text{NDV}^{\frac{1}{2}}\right)\right]_8$$

where NDV is the number of design variables. These formulas provide only very rough estimates, but are usually conservative.

Control Cards and Job Organization

WIDOWAC is composed of three separate programs. The first program CONMAN reads and processes the input data, and the second program EXEMAN executes the analysis or optimization. Additionally, a third program SUBKRN is used to generate the subsonic kernel function aerodynamic matrices that are used in the flutter analysis. If no flutter constraints are imposed, or if the aerodynamic matrices are available from previous runs, there is no need to use program SUBKRN. Otherwise it is executed after program CONMAN.

Program SUBKRN has to be executed once for each set of aerodynamic matrices (a set of aerodynamic matrices being determined by a planform, Mach number, and a set of reduced frequencies). SUBKRN outputs the aerodynamic matrices on file TAPE17 which is the fourth parameter on the program card. If more than one set of aerodynamic matrices is generated (for multiple flutter conditions) by executing SUBKRN more than once, this file name should be changed to be different for each set. Program EXEMAN has only TAPE17 in its program card so that if more files are used for the aerodynamic matrices, these files have to be added to the program card of EXEMAN.

Example:

The following example was excerpted from a WIDOWAC run on a CDC 6600 computer for three subsonic flutter conditions. The aerodynamic matrices for the third flutter

condition were calculated previously and are available on file TAPE25. It is assumed that previous control cards have placed the object decks for the three programs on files CONMAN, EXEMAN, and SUBKRN.

ALTLIB (CONMAN, EXEMAN, CONMAN) ALTLIB (EXEMAN, CONMAN, EXEMAN)	mutual exchange of common subroutines (ref. 6)
CONMAN.	
SUBKRN.	aerodynamic matrices on TAPE17
SUBKRN (,,, TAPE19)	aerodynamic matrices on TAPE19
EXEMAN.	
7/8/9	
data for CONMAN	
7/8/9	
data for SUBKRN for first flutter condition	
7/8/9	
data for SUBKRN for second flutter condition	
6/7/8/9	

Note the following:

(1) The program card of EXEMAN had to be changed to include TAPE19 and TAPE25 which involves recompilation of EXEMAN.

(2) In this example, namelist FLUTER is read in CONMAN once for each of the three flutter conditions with the NTAPE parameter being consecutively 17, 19, and 25.

(3) To avoid file conflicts, it is recommended that the file numbers for the aerodynamic matrices be 17 (that is, TAPE17) or larger.

INPUT FOR PROGRAM CONMAN

The input for program CONMAN is defined schematically in figure 4. In the following discussion, each namelist and data deck used in the input is defined. The order of the following descriptions of the data units is the same as the order of the data units in figure 4.

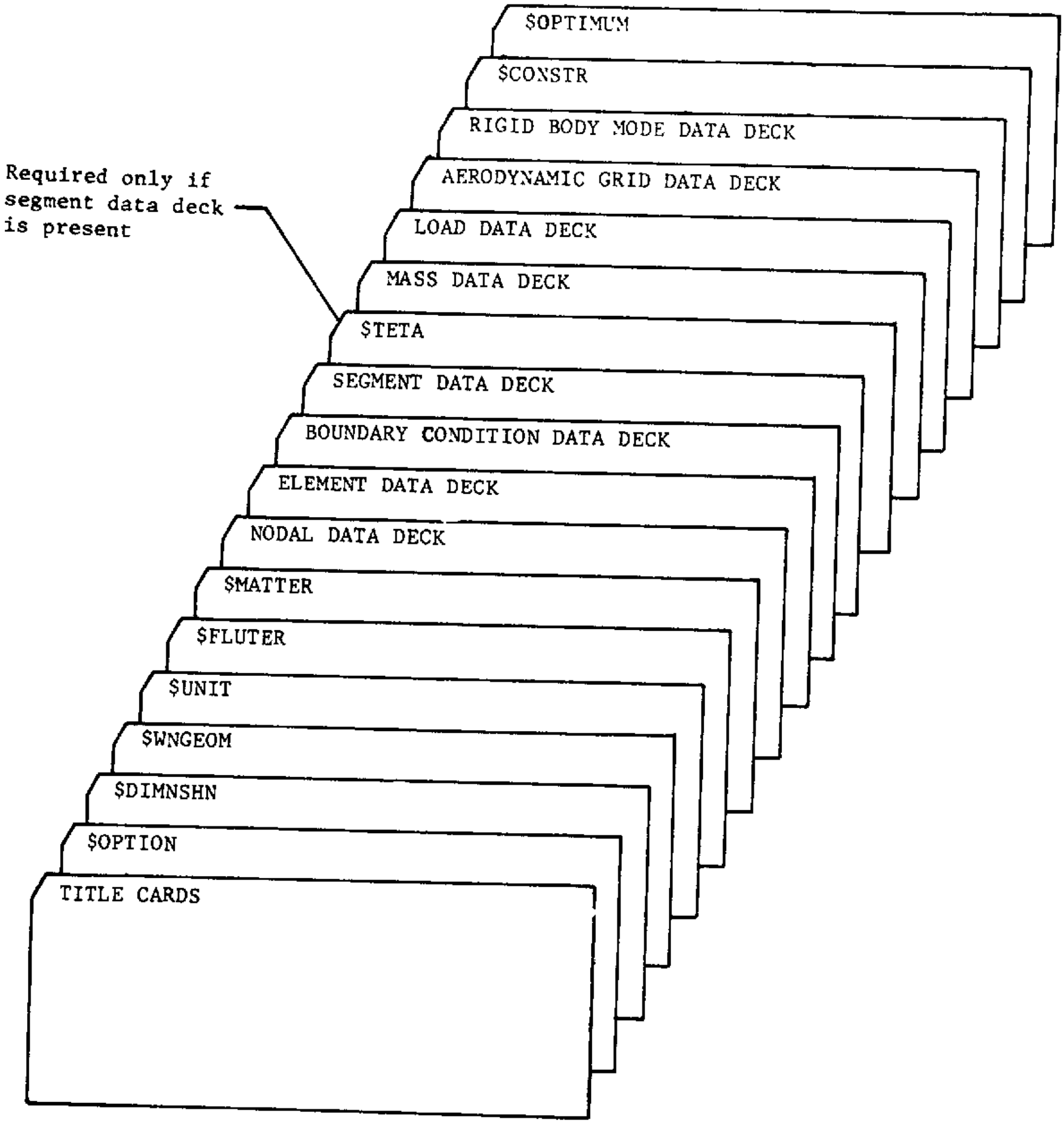


Figure 4.- Program CONMAN input data deck arrangement.

Title Cards

Any number of title cards may be used. Column one must be blank on all but the last card where it is 1. Columns 2 to 80 of all the title cards are printed at the beginning of the output.

Namelist OPTION

This namelist includes some of the control parameters for the program:

IPRINT Print control
IPRINT = 1, normal printout, see section on output below.
IPRINT = 2, besides normal output the program gives the relative addresses for each array in blank common and values of the design variables for each one-dimensional search, the derivatives of the object function, the direction of search and the values of the mass and penalty function.
IPRINT = 3, besides the output given for IPRINT = 2, the program gives the eigenvalues (natural frequencies squared) and constraint ratios for each point of a one-dimensional search, and the stress field, the displacement field, and the flutter determinant at the end of a one-dimensional search.
Default = 1

IZCOR IZCOR = 0, z coordinates calculated by assuming a circular biconvex airfoil with thickness ratio DR (see namelist WNGEOM)
IZCOR = -1, input z coordinates
Default = -1

IOPT IOPT = 1, analysis only
IOPT = 2, optimization
Default = 1

IPUNCH IPUNCH = 1, punch the natural modes.
IPUNCH = 0, do not punch the natural modes.
Default = 0

Namelist DIMNSHN

This namelist controls the storage allocation for arrays in blank common and therefore the total core requirement. Some of the parameters in the namelist have to be exact (marked below by an asterisk) and the rest are only upper bounds. All parameters have a default value of zero.

NDV	number of design variables
NEIG(*)	number of vibration modes for the flutter analysis
NEL	number of finite elements
NF(*)	number of flutter conditions
NFREE(*)	number of rigid-body modes
NL(*)	number of leading-edge cranks
NMAT	number of materials
NNOD	number of nodes
NOC(*)	number of constrained nodes
NS(*)	number of x points per y station for collocation[6]
NSN	maximum number of nodes per segment
NT(*)	number of trailing-edge cranks
NTSEG(*)	number of segments
NVEC(*)	number of eigenvectors iterated in subroutine EIJEN1. It is recommended that NVEC = 1.5* NEIG
NXP	maximum number of x points per y station[6]
NYC	number of y stations used for collocation (less than or equal to NYS)[6]
NYS	number of input y stations[6]

[6] See section "Aerodynamic Grid Data Deck."

Namelist WNGEOM

This namelist defines the wing planform:

XLR	x coordinate, leading-edge root
XLT	x coordinate, leading-edge tip
XTR	x coordinate, trailing-edge root
XTT	x coordinate, trailing-edge tip
YTIP	y coordinate, tip
XL( )	a vector containing the x coordinates of crank points on leading edge
YL( )	a vector containing the y coordinates of crank points on leading edge
XT( )	a vector containing the x coordinates of crank points on trailing edge
YT( )	a vector containing the y coordinates of crank points on trailing edge
DR	ratio of maximum depth of airfoil to local chord, applies only to biconvex airfoils for automatic generation of z coordinates (See IZCOR parameter in Namelist OPTION.)

For an uncranked wing, the following parameters may be used instead of the preceding list:

AR	aspect ratio, $\text{Span}^2/\text{Area}$
AREA	surface area, (Span) (Root chord + Tip chord)
ANGLE1	leading-edge sweep angle, degrees
TAPER	taper ratio, Tip chord/Root chord

XLR x coordinate, leading-edge root

DR ratio of maximum depth of airfoil to local chord, applies only to biconvex airfoils for automatic generation of z coordinate (See IZCOR parameter in namelist OPTION.)

Note the following:

(1) The number of leading- and trailing-edge crank points should be NL and NT, respectively, as given in namelist DIMNSHN (a maximum of 8 each).

(2) The quantity x is positive aft and y increases in the outboard direction. (See section "Coordinate System and Units.")

Namelist UNIT

The purpose of this namelist is to reconcile the user's units and scale factors with those built into the program.

LUNIT ratio of user length unit to one meter, default = 1
For example, if the length unit is the foot, LUNIT = 0.3048

MUNIT ratio of user mass unit to 1 kg, default = 1
For example, if the mass unit is the slug, MUNIT = 14.6

G gravity constant, default = 9.81

MNORM scale factor that multiplies tuning (design) masses to make their magnitudes the same order as the thickness variables, default = 0.1
For example, if the typical design thickness is 0.002 m, and the typical design mass is 100 kg, then choose MNORM = 2×10^{-5}.

Namelist FLUTER

This namelist is read once for each flutter condition to be considered. The number of flutter conditions to be considered is indicated by NF which is read in namelist DIMNSHN, and namelist FLUTER must appear NF times in the input deck. Some of the parameters in namelist FLUTER must be read for each flutter condition; others are read only for a supersonic condition, and others are read only for a subsonic condition.

The following parameters must be read for each flutter condition:

KFK	KFK = 1; supersonic condition KFK = 2; subsonic condition
OMINIT	initial frequency, radians/sec
DELOM	frequency increment, radians/sec
OMFIN	final frequency, radians/sec, needed only for IOPT = 1

The following parameters are needed for a subsonic flutter condition only:

HINIT	initial altitude, meters
DELH	altitude increment, meters
HFIN	a lower bound on flutter altitude, meters
HCR	flutter constraint altitude (matched conditions), meters
MACH	Mach number
SG	structural damping coefficient, default = 0.02
KMAX	maximum reduced frequency
KMED	median reduced frequency (half of the reduced frequencies are above KMED)
KMIN	minimum reduced frequency
NK	number of reduced frequencies for which aerodynamic matrices are available
NTAPE	file tape number for aerodynamic matrices
REF	reference frequency
IGAIN	ratio of number of entries in V,g table to NK

The following parameters are needed for a supersonic flutter condition only:

VINIT	initial speed
DELV	speed increment
VFIN	final speed, needed only for IOPT = 1
VCR	flutter constraint speed
A	speed of sound
RHOA	air mass density
GAMA	ratio of specific heats $\left(C_p/C_v\right)$

Note the following:

(1) The analysis option (IOPT = 1) of WIDOWAC can be used to provide an analysis for subsonic or supersonic conditions. For subsonic conditions, this option produces V,g tables and calculates the flutter altitude. For a supersonic condition WIDOWAC produces a table of the real and imaginary parts of the flutter determinant as a function of frequency and speed. The flutter point is found by searching the table for simultaneous change in sign of the real and imaginary parts of the flutter determinant. The grid of values of frequency and speed is determined by OMINIT, DELOM, OMFIN, and VINIT, DELV, VFIN.

(2) For IOPT = 2, OMINIT and VINIT or HINIT have to be a good approximation to the flutter point. DELOM, DELV, and DELH should be small as they are used for the purpose of calculating derivatives by using finite differences. The following values are recommended:

DELV = 10^{-5}* VINIT

DELOM = 10^{-5}* OMINIT

DELH = 0.1 meter

(3) Only TAPE17 is provided on the EXEMAN program card for aerodynamic matrices. Any number other than 17 used for NTAPE should be accompanied by a change in the EXEMAN program card.

(4) For divergence, set OMINIT = DELOM = 0.

(5) The starting point of an optimization run must satisfy the flutter constraint.

(6) KMIN, KMAX, and KMED define the range of the NK reduced frequencies for which the aerodynamic forces are calculated. (See appendix D.)

Namelist MATTER

This namelist is read once for each material (that is, NMAT times). Each material may be characterized as isotropic, orthotropic, or anisotropic. The namelist includes all the parameters which are needed for any type of material, but only the appropriate parameters should be input.

The following parameters are needed for any type of material:

IMAT	material identification number. Default = 1 for first namelist, one plus previous IMAT thereafter
RHO	mass density, default = 0
SIGMA1	stress allowable – direction 1, default = 10^{20}
SIGMA2	stress allowable – direction 2, (it is necessary[7] that SIGMA2 ≦ SIGMA1) default = 10^{20}
SIGMA12	stress allowable in shear, default = 10^{20}
IFL	terminator. Set to 1 on last MATTER Namelist

The following parameters are needed for isotropic materials:

E	Young's modulus, default = 0.
U	Poisson's ratio, default = 0.
GG	shear modulus, default = 0.

Note that if one (and only one) of the three parameters is zero by default or input, it is changed internally to conform with the relation $E = 2(1 + U)GG$.

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[7]Because the stress criterion (ref. 5) is limited to that case.

The following parameters are needed for orthotropic materials:

E1	Young's modulus, direction 1, default = 0.
E2	Young's modulus, direction 2, default = 0.
U12, U21	Poisson's ratios, default = 0.
G12	shear modulus, default = 0.

Note that if either U12 or U21 is zero by default or input, it is changed internally to conform with the relation: E1 * U21 = E2*U12.

The matrix of elastic constants QQ is needed for an anisotropic material and is based on engineering shear strains. This matrix is assumed to be symmetric and only its lower part is needed (that is, QQ(1,1), QQ(2,1), QQ(2,2), QQ(3,1) QQ(3,2), and QQ(3,3)). Default = 0 for all components of QQ.

Nodal Data Deck

This deck defines the coordinates of the nodes and may also be used to put nonstructural masses at the nodes. The z coordinates read in this deck are not used if IZCOR = 0 (see namelist OPTION), and instead, they are calculated from the formula for a biconvex surface. Each card in this deck, except the last one, has the following form:

Columns 2 to 5: node number, right justified integer

Columns 11 to 20: x coordinate

Columns 21 to 30: y coordinate

Columns 31 to 40: z coordinate

Columns 41 to 50: nonstructural mass at node

The last card in the deck has the following additional data:

Column 1: 1 (acts as terminator)

Columns 51 to 60: f_1, a scale factor that multiplies all the x coordinates, default = 1.

Columns 61 to 70: f_2, a scale factor for the y coordinates, default = 1.

Columns 71 to 80: f_3, a scale factor for the z coordinates, default = 1.

Note the following:

(1) Node numbers may appear in random order, but when all the nodal data have been read, there must be a node number for each integer from 1 to the largest node number.

(2) Node numbers should not be larger than NNOD (see namelist DIMSHN).

(3) Additional nonstructural mass may be input by using the Mass Data Deck, described in a later section.

Element Data Deck

This deck defines elements by specifying their nodes, their type, thickness, material, material orientation, and associated design variables. Each card in this deck, except the last one, has the following form:

Columns 2 to 5: element number, right justified integer

Column 10: element type

1 Rod element (isotropic only)
2 Triangular membrane element
3 Quadrilateral membrane element
4 Shear web element (isotropic only)

If blank or zero, the element type is assumed to be that of the last previously read element type number.

Columns 11 to 15: first node number, right justified integer

Columns 16 to 20: second node number, right justified integer

Columns 21 to 25: third node number, if any, right justified integer

Columns 26 to 30: fourth node number, if any, right justified integer

Columns 31 to 40: element thickness; if blank or zero, the thickness is assumed to be that of the last previously read element thickness.

Columns 41 to 45: design variable number that controls the thickness of the element, right justified integer; blank if thickness is not variable or if it is controlled by segment data.

Columns 46 to 50: material identification number (see namelist MATTER), right justified integer; if blank or zero, the material identification number is assumed to be that of the last previously read material identification number.

Columns 51 to 60: material property orientation angle THETA in degrees (angle between $+90^{\circ}$ and -90°); measured from the line defined by the first two (as read in on this card) element nodes; positive when counterclockwise from element line to material line. (See fig. 5.)

Columns 61 to 65: the segment to which this element belongs, right justified integer. If left blank, the program finds the segment, if any, containing the element from geometrical considerations.[8]

Additionally, the last card in the deck has a 1 in column 1 acting as a terminator. Note the following:

(1) Element numbers may appear in random order, but when all the element data have been read, there must be an element number for each integer from 1 to the largest element number.

(2) Element numbers should not be larger than NEL. (See namelist DIMNSHN.)

(3) Element type, thickness, or material may not be blank or zero on the first card of this deck.

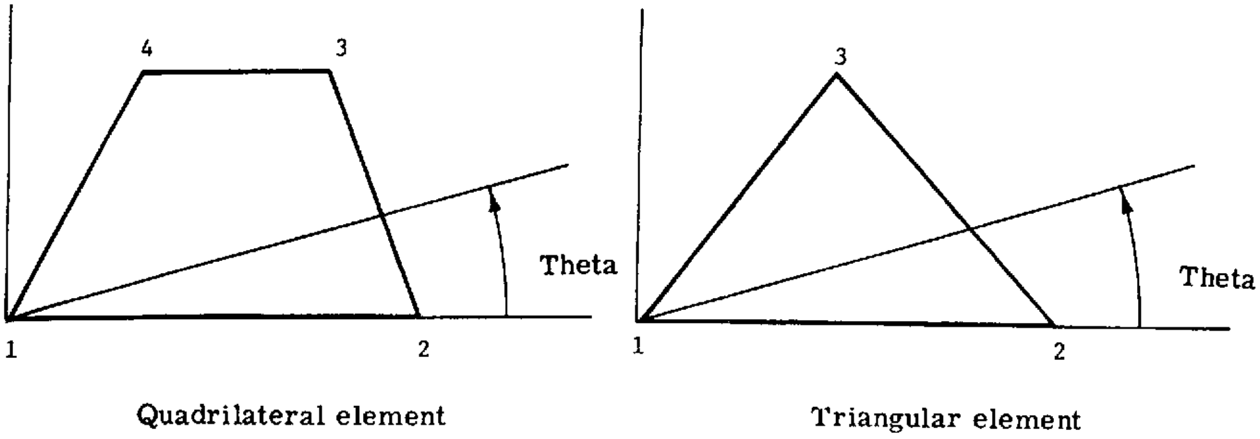

Figure 5.- Element material property orientation angle.

[8] If two segments occupy the same area (for example, two laminae of a composite material), WIDOWAC might assign the element to either one if columns 61 to 65 are left blank.

Boundary Condition Data Deck

This deck is composed of constraint cards. Each card has constraints for eight nodes, except the last card which may have less. (A total of NOC constraints is read.) Each card is divided into eight fields of 10 columns each having the following form:

Columns 1 to 5: node number, right justified integer

Column 7: 0 if x displacement is constrained to zero, 1 if unconstrained

Column 8: 0 if y displacement is constrained to zero, 1 if unconstrained

Column 9: 0 if z displacement is constrained to zero, 1 if unconstrained

The next field has similar data in columns 11 to 15, 17, 18, and 19; the next one in columns 21 to 25, 27, 28, and 29; and so on.

Segment Data Deck

This deck is composed of segment definition cards. It is omitted if there are no segments (NTSEG = 0 in namelist DIMNSHN above). If this deck is present, then namelist TETA (see next section) must also be included.

Each segment definition card (NTSEG cards) except the last one has the following form:

Columns 2 to 5: node number of first vertex, right justified integer

Columns 6 to 10: node number of second vertex, right justified integer

Columns 11 to 15: node number of third vertex, right justified integer

Columns 16 to 20: node number of fourth vertex, if any, right justified integer

Columns 21 to 30: thickness at first vertex

Columns 31 to 40: thickness at second vertex

Columns 41 to 50: thickness at third vertex

Columns 51 to 60: thickness at fourth vertex, if any

Columns 61 to 65: number of the design variable which controls the thickness of the first vertex, right justified integer

Columns 66 to 70: number of the design variable which controls the thickness of the second vertex, right justified integer

Columns 71 to 75: number of the design variable which controls the thickness of the third vertex, right justified integer

Columns 76 to 80: number of the design variable which controls the thickness of the fourth vertex, if any, right justified integer

The last segment definition card also has a 1 in column 1 as a terminator.

Note the following:

(1) If there is no design variable associated with a segment vertex, the appropriate column is left blank.

(2) Segments are numbered in the order that they are read in.

(3) Segment data override element data for determining element thicknesses, unless the thicknesses of all vertices are set to a value of -1. (That is, set the thickness of the

segment vertices to -1 when the segment is to be used for defining the incremental thickness during the design process but not the minimum gage structure.)

(4) The segment nodes must be read in cyclical order (clockwise or counterclockwise).

(5) Also see section "Design Variables and Segments."

Namelist TETA

This namelist is part of the segment data and must be included if the segment data deck is present.

ITHETA	ITHETA = 0, material angles defined by element data deck. ITHETA = 1, material angles defined by THTSEG.
THTSEG(I)	angle between principal material axis in segment I and x-axis; positive when counterclockwise from x-axis to material axis.

Mass Data Deck

This deck inputs the nonstructural mass. If no nonstructural mass is used, this deck consists of one card with the word NOMAS (keyword indicating that there is to be no mass data) in columns 2 to 6. The following options are available:

(1) Concentrated masses, each of magnitude m, are placed at nodes j where $j = n_1(1)n_2$. If desired, the magnitude of these masses may be made variable (tuning mass) and controlled by design variable i. For tuning masses the initial value of a mass is defined by the value of the design variable input in namelist OPTIMUM. (See section "Namelist OPTIMUM.") Each card has the following form:

Columns 2 to 6: CMASS, key word to represent concentrated mass being read in

Columns 11 to 15: n_1, right justified integer

Columns 16 to 20: n_2, right justified integer

Columns 21 to 30: m

Columns 31 to 35: i, right justified

(2) Distributed masses of density ρ per unit area (unit length for rod elements) are placed over elements j, where $j = n_1(1)n_2$. Each card has the following form:

Columns 2 to 6: PMASS, key word to indicate distributed mass per unit area (unit length for rod element) being read in

Columns 11 to 15: n_1, right justified integer

Columns 16 to 20: n_2, right justified integer

Columns 21 to 30: ρ

(3) Distributed masses of density ρ per unit volume (for example, fuel) are placed between elements j, where $j = n_1(1)n_2$, and the wing middle surface. Each card has the following form:

Columns 2 to 6: VMASS, key word to indicate distributed mass per unit volume being read in

Columns 11 to 15: n_1, right justified integer

Columns 16 to 20: n_2, right justified integer

Columns 21 to 30: ρ

The last card in the deck has to have a 1 in column 1.

Note the following:

(1) Option 3 (VMASS) may only be used for membrane cover elements.

(2) If there is no design variable associated with a concentrated mass, the appropriate columns are left blank.

Load Data Deck

This deck inputs the loads on the wing. If there are no loads, the deck consists of one card with the word NOLOD (key word indicating no load) in columns 2 to 6.

The following options are available:

(1) Concentrated load vector $\left(F_X, F_Y, F_Z\right)$ placed at nodes n_1 to n_2. Each card has the following form:

Columns 2 to 6: CLOAD, key word to indicate constant load vector

Columns 11 to 15: n_1, right justified integer

Columns 16 to 20: n_2, right justified integer

Columns 21 to 30: F_X

Columns 31 to 40: F_Y

Columns 41 to 50: F_Z

(2) Distributed load in z direction of magnitude p per unit projected area (over x,y plane) placed over cover elements n_1 to n_2. Each card has the following form:

Columns 2 to 6: PLOAD, key word to indicate distributed load per unit projected area being read in

Columns 11 to 15: n_1, right justified integer

Columns 16 to 20: n_2, right justified integer

Columns 21 to 30: p

The last card of load data deck must have a 1 in column 1.

Aerodynamic Grid Data Deck

This deck defines the nodes of the aerodynamic grid (see section "Aerodynamic Grid") and is omitted if there are no flutter conditions (that is, NF = 0). The nodes of the aerodynamic grid are a subset of the nodes of the finite element model and have to be along chordwise stations (constant y). This statement means that enough of the finite-element nodes have to be along chordwise lines so that these nodes would be adequate for the definition of the vibration modes over the entire wing.

The aerodynamic grid data deck consists of four groups of cards:

(1) Chord definition cards: There are NYS (see namelist DIMNSHN) nondimensional y coordinates (fraction of the semispan), with 8 coordinates per card and 10 columns per coordinate (8E10.0). They must be monotonically increasing.

(2) Number of nodes for each of the NYS chords defined in the previous group, with 16 numbers per card, and 5 columns per integer, right justified (16I5). No number on this card may be larger than NXP. (See namelist DIMNSHN.)

(3) Definition of collocation chords: There are NYC integers defining which of the chords in group 1 are used for collocation, with 16 integer numbers per card, and 5 columns per integer, right justified (16I5). The root and tip chords may not be used for collocation. The program automatically defines NS (see namelist DIMNSHN) collocation

points per collocation chord. If only supersonic flutter conditions are imposed, the collocation data are immaterial, and this group should consist of a blank card.

(4) Node definition: There are NYS sets of data in this group with the ith set containing the node numbers for the ith chord, with 16 integer numbers per card, and 5 columns per integer, right justified (16I5). If there are more than 16 nodes on a chord, use more than one card for that station.

Rigid-Body-Mode Data Deck

This deck defines NFREE rigid-body modes. It is omitted if NFREE = 0 (NFREE is read in namelist DIMNSHN). The first card of this deck uses the first NFREE columns to define the type of each of the modes. Each one of the first NFREE columns of this card may have a number from 0 to 3.

0	user inputs the rigid-body mode
1	plunging mode
2	pitching mode
3	rolling mode

For each mode of type 0, the z-displacement at the nodes follow, 7 numbers per card in columns 1 to 10, 11 to 21, 21 to 30, 31 to 40, 41 to 50, 51 to 60, and 61 to 70. For example, if a plunging mode and a rolling mode are to be included NFREE = 2 and the only card in this deck has a 1 in column 1 and a 3 in column 2.

Namelist CONSTR

This namelist defines the constraints (see section "Optimization Method") which apply to the design process or to the kind of analysis to be performed. All the parameters in this namelist are type LOGICAL and may take only the values .TRUE. or .FALSE. Default = .FALSE.

FLUTTER	flutter analysis or constraints
STRESS	stress analysis or constraints
GAGE	minimum gage constraint

It is recommended that a minimum gage constraint always be used. This constraint prevents the program from considering designs with negative thicknesses or masses.

Namelist OPTIMUM

This namelist inputs the data needed for the optimization process but also may be useful in an analysis run. For example, after an optimization run the resulting design may be analyzed as a final check, and this namelist may be used to input the final values of the design variables C(I).

R	factor multiplying the penalty function, usually chosen to make the initial penalty function roughly equal to the mass. Default = 50.
RDC	R reduction factor. Default = 20.
C(I)	initial values for design variables. Default for a given C(I) is the value of the last previously read thickness or mass assigned to the design variable.
TUL(I)	weighting factors for constraints. Default = 1 for all constraints, except the stress constraint which is 30.

Note the following:

(1) For assigning value for the TUL(I), note that the constraints are ordered so that the NF flutter constraints occur first, followed by the stress constraint, and finally the minimum gage constraint.

(2) Note that this namelist is read only if a nonzero design variable identification number exists. (See element, segment, and mass data decks.) Therefore, to perform an analysis using this namelist, retain the design variable identification numbers and value of NDV from a previous optimization run and set IOPT = 1 in namelist DIMNSHN.

INPUT FOR PROGRAM SUBKRN

This program is needed only if subsonic aerodynamic matrices are needed for a combination of wing planform and sets of Mach number and reduced frequencies, for which these matrices are not available from a previous run.

Title Card

One title card is read in and is written by SUBKRN on the appropriate subsonic aerodynamic-matrix data file before the aerodynamic matrices data.

Namelist NAM1

This namelist defines the Mach number and reduced frequencies for which the aerodynamic matrices are calculated.

MACH	Mach number, real number.
NK	number of reduced frequencies. Default = 20
KMAX	largest reduced frequency. Default = 4.0
KMED	median reduced frequency. Default = 1.0
KMIN	minimum reduced frequency. Default = 0.0

Note that KMIN, KMAX, and KMED define the range of the NK reduced frequencies for which the aerodynamic forces are calculated. (See appendix D.)

OUTPUT

Output of Program CONMAN

The main function of this program is to process the input data and, therefore, the output is primarily a reflection of the input. The output items of the program are listed and explained whenever an item is more than a simple printout of a corresponding input item.

(1) Title cards.

(2) Input options – printout of namelist OPTION.

(3) Printout of namelist DIMNSHN.

(4) $ADRESS – a list of the relative addresses (decimal) of arrays in blank common. Printed if IPRINT > 1 in namelist OPTION.

(5) Leading- and trailing-edge cranks. XL,XT are the x-coordinates of the leading- and trailing-edge cranks, respectively, read in namelist WNGEOM. Printed if there are any cranks.

(6) Wing description – global parameters either read in namelist WNGEOM or calculated from other data in this namelist.

(7) Printout of namelist UNIT.

(8) Flutter conditions, if any. Printout of namelist FLUTER.

(9) Material properties. Printout of namelist MATTER. Data for isotropic or orthotropic materials are processed and printed out in the general form of an anisotropic material.

(10) Segment data, if any. Printout of data read in the segment data deck and in namelist TETA.

(11) Nodal data. The column labeled NRR contains zeros for constrained degrees of freedom and ones for unconstrained degrees of freedom.

(12) Load data.

(13) Total mass.

(14) Element data.

(15) Aerodynamic grid data, if any.

(16) Rigid body modes, if any.

(17) Design constraints considered. Printout of namelist CONSTR.

(18) Input data for search routine. Printout of some of the data read in namelist OPTIMUM (if IOPT = 2 in namelist OPTION).

(19) Design variable data, if any. Each design variable is identified with the thicknesses and masses that it controls. Also given are its initial value and derivative of the total mass with respect to the design variable (obtained by forward finite differences).

(20) Total number of degrees of freedom and total storage area required for arrays in blank common.

Output of Program EXEMAN

Program EXEMAN prints out the results of the initial analysis, the results of the final analysis, and if IPRINT > 1, also some intermediate results. The output consists of the following items:

(1) $ADRESS – Relative addresses (decimal) of arrays in blank common. Printed if IPRINT > 1 in namelist OPTION.

(2) Length of blank common required for the program EXEMAN.

(3) Displacement field. Printed if STRESS = .TRUE. in namelist CONSTR.

(4) Stress and thickness[9] for each element. Printed if STRESS = .TRUE. in namelist CONSTR.

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[9]If design variables are used, this thickness is the increment over the minimum gage thickness printed before in the element data.

(5) Eigenvalues. The squares of the natural frequencies $(\text{rad/sec})^2$. Printed if FLUTTER = .TRUE. in namelist CONSTR, and IPRINT = 3 in namelist OPTION.

(6) Flutter analysis. The results of the analysis for each flutter condition are given. Four cases are possible.

(a) Subsonic condition, IOPT = 1. For a subsonic analysis V,g tables are printed for three altitudes. The first altitude is the one given as HINIT in namelist FLUTER, the other two are determined by the program in a search for a matched flutter point. (See section "Flutter Calculations.") For each altitude the flutter speed (normalized by reference length and reference frequency) and flutter frequency at the lowest crossing are given at the end of the V,g table. The predicted matched point altitude, which is used for the next V,g table is also given along with an error code ICODE. If ICODE $\neq$ 0, the program could not find a matched altitude consistent with the requirement of constant flutter dynamic pressure. ICODE = 1 denotes that more than 30 iterations were needed, ICODE = 3 denotes that no matched altitude occurs in the altitude range -10 000 m to 60 000 m.

(b) Subsonic condition, IOPT = 2. For a subsonic optimization run, the program prints a table of the real and imaginary parts of the flutter determinant as a function of the frequency and the altitude. The Newton-Raphson method is used to drive the flutter determinant to zero. If, after seven iterations, convergence has not been obtained, the process is stopped and an initial point closer to the flutter point is required in this case.

(c) Supersonic condition, IOPT = 1. For a supersonic analysis the program prints the real and imaginary parts of the flutter determinant for a grid of values of the frequency and speed determined by the parameters OMINIT, DELOM, OMFIN, VINIT, DELV, and VFIN in namelist FLUTER. The user can locate the flutter point by determining where both the real and imaginary parts of the flutter determinant change signs simultaneously.

(d) Supersonic condition, IOPT = 2. For a supersonic optimization run, the program prints a table of the real and imaginary parts of the flutter determinant as a function of the frequency and speed. The Newton-Raphson method is used to drive the flutter determinant to zero. If, after seven iterations, convergence has not been obtained, the process is stopped and an initial point closer to the flutter point is required in this case.

The following output is obtained only for optimization, IOPT = 2.

(7) Constraint ratios g_i. Each ratio represents the status of one constraint. If $g_i \ll 1$, then the design is close to the ith constraint. The NF flutter constraints, if any, are given first, then the stress constraint, and minimum gage constraint, in that order.

(8) Variable mass, total structural mass, penalty function, and current values of design variables (CONSTANTS).

(9) If IPRINT = 3, outputs (5) and (7) are printed as each design variable is incremented for the purpose of derivative calculation.

(10) Move direction data to start a one-dimensional search. The derivatives of the object function, the current values of design variables (CSAV), and the direction cosines of the move are printed if IPRINT > 1.

(11) Outputs (5) and (7) are printed for each point of a one-dimensional search if IPRINT = 3.

(12) The penalty function and mass at the end of a one-dimensional search and the distance traveled are printed if IPRINT > 1. The stress field and the flutter determinant are printed if IPRINT = 3.

(13) An estimate of how much the object function (PFUNC) is above a minimum of its current value, given as a fraction Q, is printed if IPRINT > 1.

Steps 9 to 13 are repeated until convergence is assumed for a given value of R because of any one of the following three conditions:

(1) Gradient convergence, the gradient of the object function is smaller than 0.05 times the gradient for the initial design.

(2) Quadratic convergence, the error prediction Q before the last move is less than 2 percent (0.02).

(3) The limit on the number of one-dimensional searches is 5.

Print out the ratio (CTEST) of the penalty function (PF) to the object function (PFUNC) if IPRINT > 1. If CTEST > 0.02, reduce R by RDC and go to step 14. If CTEST ≦ 0.02, the optimization is considered to be complete and steps 3 to 7 are printed out.

(14) The values of the design variables C(I) and final masses are printed for the final design. The final values of the design variables may now be used to make an analysis run as a check on the flutter constraints.

EXAMPLE PROBLEMS

Three example problems are presented to demonstrate the use of WIDOWAC. Example 1 illustrates the analysis capability of WIDOWAC with multiple flutter conditions. Example 2 demonstrates the optimization capability of WIDOWAC for both a subsonic and a supersonic flutter condition and includes a concentrated tuning mass as one of the design variables. Example 3 demonstrates a divergence problem. Comments on the input data

and a discussion of the results for each example are provided in this section. The actual input data and program output are presented in appendix F.

Example 1: Full-Depth Sandwich Wing – Analysis Run

The analysis capability of the program is demonstrated by carrying out the stress analysis, two different subsonic flutter analyses, and one supersonic analysis of the biconvex airfoil delta wing shown in figure 6.

The structure is represented by 100 finite elements, 38 grid points, and 6 segments. Figure 6(a) shows the layout of the segments. Zero-deflection boundary conditions are applied to the 7 grid points along the root in order to simulate a clamped condition. (See fig. 6(b).) The shear web elements are made very stiff to represent a very rigid sandwich core. An aerodynamic grid point network shown in figure 6(b) is used with 7 stations in the y direction (spanwise) and varying number of stations in the x direction (chordwise). The numbered structural grid points in figure 6(b) make up the aerodynamic grid point network. Four of these y stations (see fig. 6(b)) are used for collocation (subsonic aerodynamics) with four x stations per y station. The flutter analysis uses the first five natural vibration modes which are a subset of nine modes that are generated by the iteration procedure in order to accelerate the convergence of the first five modes.

Input to CONMAN

<u>TITLE CARD</u> One title card is used

<u>$OPTION</u> IOPT is set for an analysis run and IZCOR is set for a biconvex wing

<u>$DIMNSHN</u> Parameters are set to the appropriate values for this case to provide array-dimension data to the program

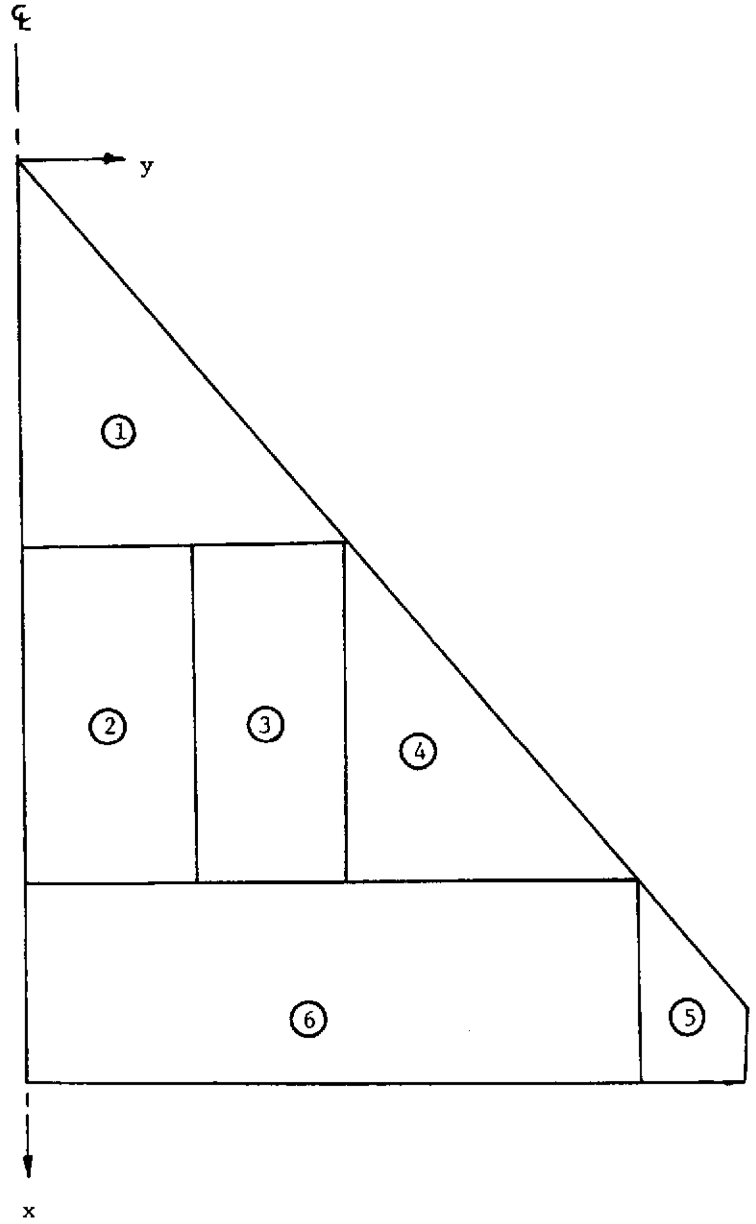
<u>$WNGEOM</u> Geometric data for the wing are input

<u>$UNIT</u> The English system of units is used to define this example with the inch as the basic length unit. Since the program has been coded to conform with the SI system of units, LUNIT and MUNIT must be set to the appropriate conversion factors

LUNIT = 0.0254 since 1. in. = 0.0254 meters and

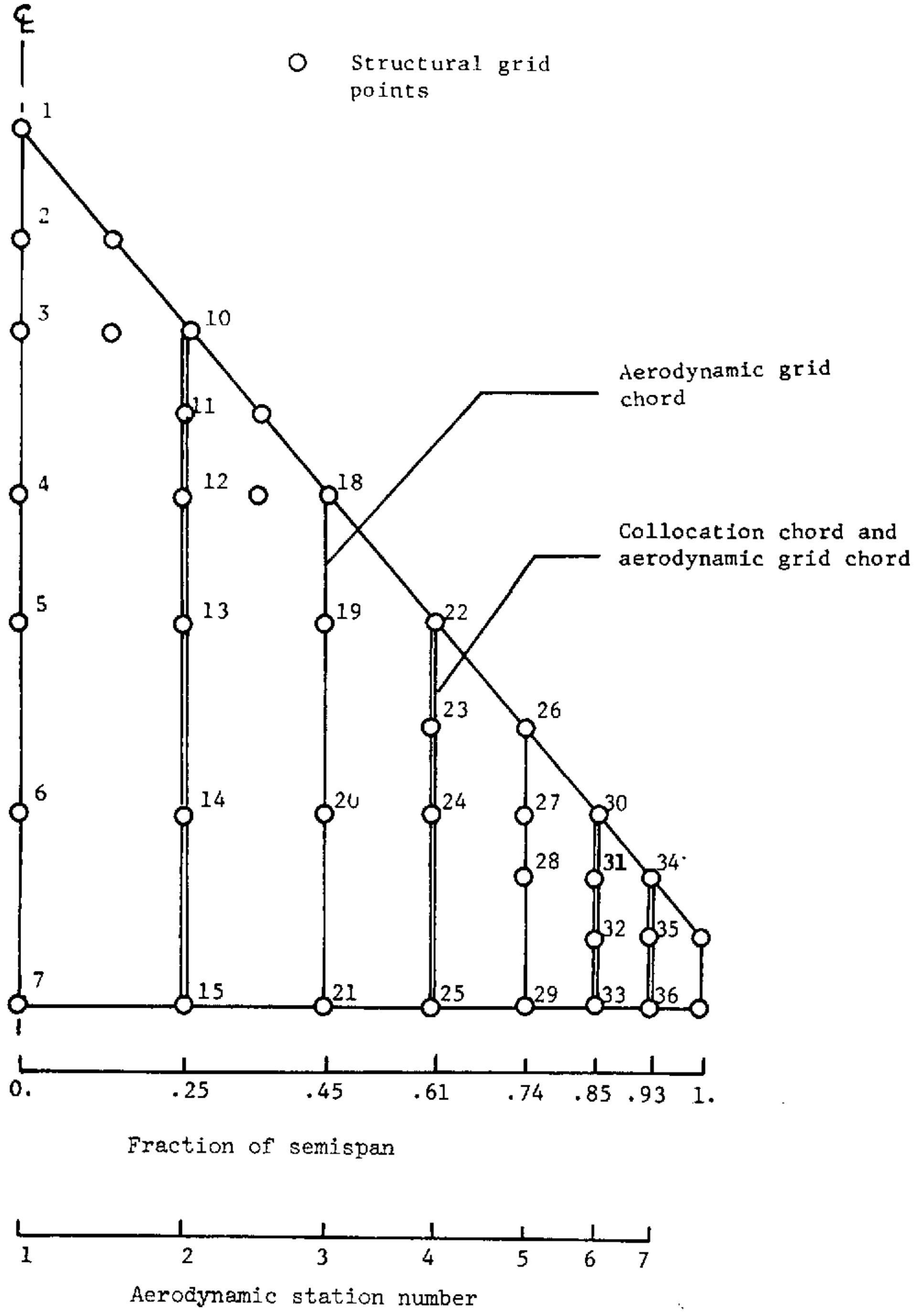
MUNIT = 175.1268348 since 1. slug = 14.5939029 kg or

1. lb-sec^2/in. = (12.)(14.5939029) = 175.1268348 kg



(a) Segment definition. Circled numbers represent segments.

Figure 6.- Example 1.



(b) Aerodynamic grid and collocation chords. Aerodynamic collocation points do not correspond to structural grid points in general.

Figure 6.- Concluded.

$FLUTER — Namelist FLUTER is required once for each of the three flutter conditions considered in this example. Flutter condition 1 is to be subsonic at a Mach number equal to 0.6 and an initial altitude of -1524 meters (-5000 ft). Note that the program always requires that altitudes be input in meters regardless of the units assumed for the model. Note that the default values of SG, IGAIN, and NTAPE were used for this flutter condition. With the default value of NTAPE, the aerodynamic matrices are written on file TAPE17. Flutter condition 2 is to be subsonic at a Mach number equal to 0.75 and an initial altitude of 3048 meters (10 000 ft). The required input is as in flutter condition 1 but the aerodynamic matrices for this flutter condition are written on file TAPE18. Flutter condition 3 is to be supersonic with an air density of 0.549 kg/m^3 (5.14×10^{-8} lb-sec^2/in^4), a speed of sound of 309.98 m/sec (12204 in/sec), and a specific heat ratio of 1.4.

$MATTER — Two materials are used to represent the structural model; therefore, namelist MATTER is required once for each material.

NODAL DATA DECK — In this example, the x coordinates of the nodal points are input as fractions of the root chord, and the y coordinates are input as fractions of the semispan. The true physical coordinates of the nodal points are generated by the use of the multiplication factors F(1) and F(2) on the last nodal point card. F(1) is input as the root chord, and F(2) as the semispan.

ELEMENT DATA DECK — Elemental thicknesses are set to 0.0508 cm (0.020 in.) for elements 1 to 51, and to 24.89 cm (9.8 in.) for elements 52 to 100 by placing the appropriate thickness value on the input cards for elements 1 and 52.

BOUNDARY CONDITION DATA DECK — The seven nodal points on the root chord are totally constrained to simulate a clamped root condition.

SEGMENT DATA DECK — The six segments are defined by their vertices and vertex thicknesses are set for each vertex. If a vertex thickness is positive, it overrides any

element thickness that may have been read in by an element card. The vertex thicknesses for segment 5 are read in as -1.0; therefore, the thicknesses of the elements in segment 5 are used in the analysis.

$TETA — ITHETA is set equal to zero and indicates that the material angles are defined by the appropriate element data.

NONSTRUCTURAL MASS DATA DECK — A distributed mass of 470.2 kg/m^3 (4.4×10^{-5} lb-sec^2/in^4) is placed in the volume between the x,y plane and the skin elements 1 to 51 to represent fuel mass.

LOADING CONDITION DATA DECK — A distributed pressure load in the z direction of 3447 Pa (0.5 lb/in^2) is applied to elements 1 to 51.

AERODYNAMIC GRID DATA DECK — Seven spanwise chords are used for the aerodynamic grid with 3 to 7 chordwise stations each. Four of the spanwise chords are used as collocation chords when solving the downwash equations in the subsonic flutter analysis. The program automatically generates four collocation points on each of these chords since NS was specified as 4 in namelist DIMNSHN.

$CONSTR — FLUTTER and STRESS are set to .TRUE. to indicate that a combined stress and flutter analysis is to be made.

$OPTIMUM$ — This namelist is read in without any data since only an analysis is to be performed.

Input to SUBKRN

Subsonic aerodynamic data for flutter condition 1 are available on a physical tape from a previous solution. This tape is copied to disk file TAPE17 by a control card in the job control deck. Therefore, program SUBKRN is not executed for flutter condition 1.

Subsonic aerodynamic data for flutter condition 2 have to be generated by SUBKRN and are written on file TAPE18. TAPE18 is selected for this flutter condition by setting

NTAPE equal to 18 in namelist FLUTER. The appropriate job control cards for TAPE18 are also required.

The input for flutter condition 2 is

TITLE CARD — One title card is used.

\$NAM1 — Input data for MACH, NK, KMAX, KMIN, and KMED are required.

Results

For the subsonic flutter conditions, the program generates V,g tables for three altitudes and finds the matched flutter point. These matched points can be used as starting points for subsequent optimization runs.

For the supersonic flutter conditions, the program determines the real and imaginary parts of the flutter determinant for a grid of speed and frequency values. In this case, the speed is varied from 381 m/sec (1.5×10^4 in/sec) to 1016 m/sec (4.0×10^4 in/sec) in increments of 25.4 m/sec (1.0×10^3 in/sec), and frequency is varied from 0 to 20 rad/sec in increments of 1 rad/sec. There is a simultaneous sign change in the real and imaginary parts of the flutter determinant at a frequency between 16 and 17 rad/sec and at a speed between 787 m/sec (3.1×10^4 in/sec) and 940 m/sec (3.7×10^4 in/sec). If this analysis run is made to establish initial conditions for an optimization run, and if the present results are not close enough to start a Newton-Raphson search (IOPT = 2), the flutter point can be determined more accurately by carrying out a second analysis with frequency and speed ranging between these limits with smaller increments.

Example 2: Full-Depth Sandwich Wing – Optimization Run

The optimization capability of WIDOWAC is demonstrated in this example for both a subsonic and supersonic flutter condition. The wing is the same as in example 1, except one concentrated tuning mass has been added and five segments are used as shown in figure 7. The elements in the extreme tip are not contained within a segment. Stress, flutter, and minimum gage constraints are imposed for the optimization procedure. Seven design variables are used in this example – six segment vertex thicknesses and one concentrated tuning mass.

Input for CONMAN

TITLE CARD — One title card is used.

\$OPTION — IOPT is set for an optimization run. IPRINT is set for extra details for each one-dimensional search.

$DIMNSHN The parameters that set the dimensions of the program are set as in example 1. In this example, NF is set equal to 2 since there are two flutter conditions, and NDV is set equal to 7 since there are seven design variables.

$WNGEOM Same as in example 1.

$UNIT LUNIT and MUNIT are the same as in example 1. MNORM is set equal to 0.1 (default value) and is used to scale the concentrated tuning mass design variable to the same order as the thickness design variables.

$FLUTER Namelist FLUTER is read once for each of the two flutter conditions. Flutter condition 1 is a subsonic condition and requires OMINIT, DELOM, HINIT, DELH, HFIN, HCR, NK, KMAX, KMIN, KMED, REF, KFK, and MACH. Recall that altitudes must be input in meters. The default value of NTAPE was used for this example. Flutter condition 2 is a supersonic condition and requires OMINIT, DELOM, VINIT, DELV, VCR, A, RHOA, GAMA, and KFK.

$MATTER Same as in example 1.

NODAL DATA DECK Same as in example 1.

ELEMENT DATA DECK Same as in example 1.

BOUNDARY CONDITION DATA DECK Same as in example 1.

SEGMENT DATA DECK Five segments are defined with the variable part of the segment vertex thicknesses being identified with six design variables. (See fig. 7.) The segment vertex thicknesses read in with the segment data deck are the minimum gage thicknesses for the segment vertices. The segment vertex thicknesses override the element thicknesses of the elements contained within the segments. The variable part of the segment vertex thicknesses are input in namelist OPTIMUM.

$TETA Same as in example 1.

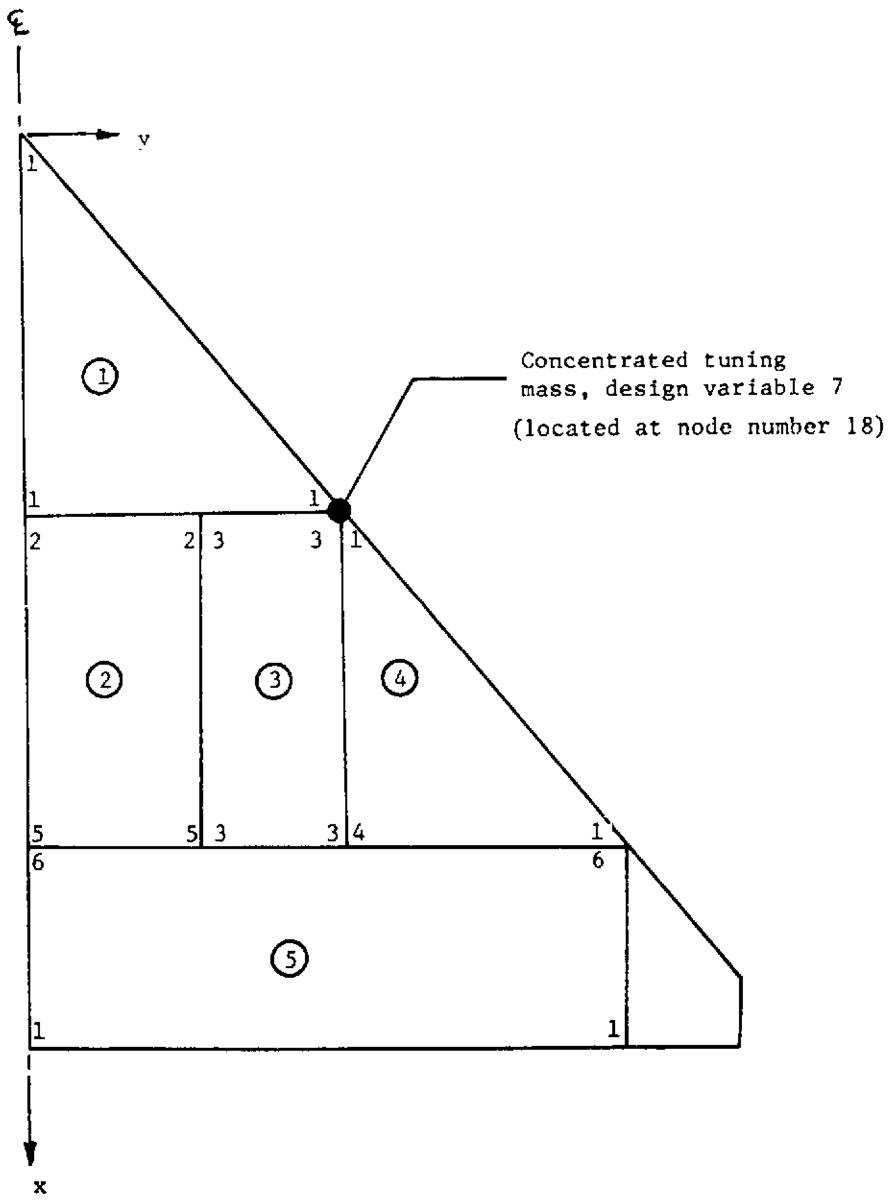


Figure 7.- Segment and design variable definitions for example 2. Circled numbers represent segments; uncircled numbers represent design variables.

NONSTRUCTURAL MASS DATA DECK — The concentrated tuning mass is input with a CMASS card and is applied at nodal point 18. It is identified as the seventh design variable and its initial mass value is input in namelist OPTIMUM. The fuel mass for the wing is input as in example 1.

LOADING CONDITION DATA DECK — Same as in example 1.

AERODYNAMIC GRID DATA DECK — Same as in example 1.

$CONSTR — FLUTTER, STRESS, and GAGE are all set equal to to .TRUE. to apply flutter, stress, and minimum gage constraints for the flutter procedure.

$OPTIMUM — The variable part of the segment vertex thicknesses, design variables C(1) to C(6), are set equal to 0.203 cm (0.08 in.). The concentrated tuning mass design variable C(7) is given its initial value. R and RDC are also input on this card.

Input for SUBKRN

The subsonic flutter condition requires the execution of SUBKRN.

TITLE CARD — One title card is used.

$NAM1 — The variables MACH, NK, KMAX, KMIN, and KMED are applied.

Discussion of Results and Output

The output of CONMAN is primarily a printout of the input. In addition, the identification of each design variable with the segment vertex thicknesses or the mass that it is controlling is given. Note that the masses are in units of lb-sec^2/in. for this example. The output of EXEMAN contains the displacement field, stress field, and the flutter determinant for the two flutter conditions.

The constraint terms G(1) to G(4) indicate how close the initial structure is to the constraints. The quantities G(1) and G(2) are for the two flutter conditions, G(3) is for the stress constraint, and G(4) is for the minimum gage constraint. The value for

G(3) is large because it is calculated as an average for all elements, and most elements have very low stress ratios. (The stress ratio is defined in the section "Optimization Method.") To compensate for the stress constraint G(3), the value of TUL(3) is input as 30 (whereas TUL(1) = TUL(2) = TUL(4) = 1) so that the stress constraint is given extra weight compared with the other constraints.

The mass (WT) of the initial design is about 3047 kg (17.4 lb-sec^2/in.). Note that this is the mass of the variable part of the structure (that is, it does not include the minimum gage). The total structural mass (TWT) is 3800 kg (21.7 lb-sec^2/in.). The penalty function is close to the mass in magnitude as is recommended.

For each one-dimensional search, the first derivative of the sum of the mass and penalty function, the values of the design variables at the beginning of the search (CSAV), and the direction cosines of the move are given. The first move is not close to the steepest descent direction. At the end of the one-dimensional search, the current values of the penalty function (PF), mass (WT), and length of one-dimensional move (S) are printed. On the first move, the first design variable was reduced from 0.08 to 0.0286.

Four one-dimensional searches are executed for the first value of the penalty function coefficient R. On the fourth move, the mass increased. It is not the mass which is minimized, however, but the sum of the mass and penalty function. Both the values of the mass and the penalty function, however, are lower at the end of that move than they were for the initial design. This condition means that as the mass is reduced, the distance to the constraints increased. When quadratic convergence is achieved at the end of the fourth move, R is reduced by a factor RDC to let the design get closer to the constraints.

For the second value of R, five one-dimensional searches are executed and this terminates the optimization for that value of R. Four one-dimensional searches are executed for the third value of R, and two for the last value of R. The penalty function coefficient R is not reduced any further because PF is less than 2 percent of the mass (WT).

The displacements, stresses, and flutter altitude (if subsonic) or flutter speed (if supersonic) are given for the final design. The final design is close to the critical altitude for the first (subsonic) flutter constraint (final altitude 1511 m compared with 1425 m critical) and is close to the stress constraint for finite elements 19 and 31. The final mass of the variable structure (WT) is 1375 kg (7.85 lb-sec^2/in.). The final value of the total structural mass (TWT) is 2126 kg (12.14 lb-sec^2/in.).

Example 3: Built-Up Wing With a Divergence Constraint

This example demonstrates the technique used in overcoming a divergence problem that existed for a stress design obtained from a previous run. Both element and segment

vertex thicknesses are used as design variables. The structural model, shown in figure 8, represents a wing and part of the fuselage. The structure is represented by 218 finite elements, 69 grid points, and 2 segments. The wing has leading- and trailing-edge cranks, nonstructural masses, and two rigid-body modes. An aerodynamic grid point network is used with seven stations in the y direction and a varying number of stations in the x direction. Six of the y stations are used for collocation with six x stations per y station. Divergence and minimum gage (the stress design obtained in a previous run) constraints are imposed for the optimization procedure, and two design variables are used.

Input to CONMAN

TITLE CARD	One title card is used.
$OPTIMUM	IOPT is set for optimization and IZCOR is set to indicate that z coordinates are to be read in.
$DIMNSHN	Parameters are set to the appropriate values for this case to provide array-dimension data for the program.
$WNGEOM	The appropriate coordinates required to define the wing with its leading- and trailing-edge cranks are read in. Because of the cranks, it is not possible to define the wing geometry by using global parameters such as aspect ratio or taper ratio.
$UNIT	Same as in example 1.
$FLUTER	SG, OMINIT, and DELOM are set equal to zero since a divergence condition is being enforced.
$MATTER	Namelist MATTER is required once for each of the two materials used to represent the structural model.
NODAL DATA DECK	The nodal coordinates are read in.
ELEMENT DATA DECK	The element data are read in. The thicknesses of elements 127 to 142 are to be controlled by design variable number 2 as indicated on their input cards. Elements 214, 215, and 216 are rod elements that tie the aft part of the wing to the body representing a simple support for that part of the wing.

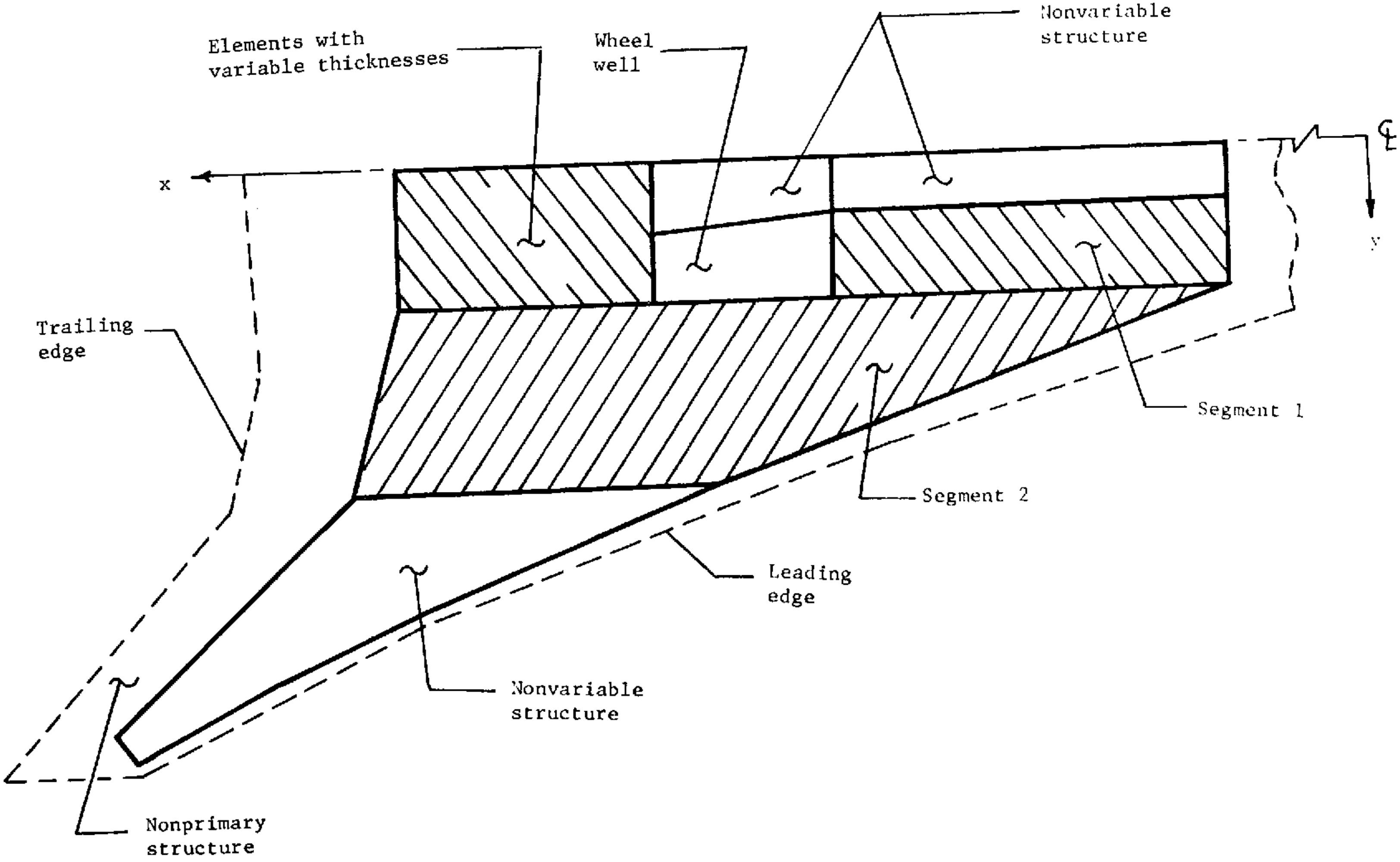


Figure 8.- Segment and design variable definitions for example 3.

BOUNDARY CONDITION DATA DECK

The boundary representing the wing-fuselage intersection is only partially constrained to allow for a more realistic wing-fuselage interaction. The resulting unrestrained degrees of freedom allow two rigid-body modes which are accounted for in the Rigid-Body-Mode Data Deck.

SEGMENT DATA DECK

Two segments are defined with all their vertex thicknesses controlled by design variable number 1. Segment vertex thicknesses do not override the element thicknesses since they are set equal to -1.

$TETA

Same as in example 1.

NONSTRUCTURAL MASS DATA DECK

A fuel mass of 534.5 kg/m^3 (5.001×10^{-5} $lb\text{-}sec^2/in^4$) is distributed in the volume between the x,y plane and elements 105 to 112 and 123 to 182. Concentrated masses are used to represent the engines and nonstructural aerodynamic fairings at the leading and trailing edges of the wing.

LOADING CONDITION DATA DECK

A distributed pressure load in the z-direction of 3447 Pa (0.5 lb/in^2) is applied to elements 105 to 194.

AERODYNAMIC GRID DATA DECK

Seven spanwise chords are used for the aerodynamic grid with three to eight chordwise stations each. Six of the spanwise chords are used as collocation chords when solving the downwash equations in the subsonic flutter analysis. The program automatically generates six collocation points on each of the chords since NS was specified as 6 in namelist DIMNSHN.

RIGID-BODY-MODE DATA DECK

Pitching and plunging rigid-body modes are specified.

$CONSTR — FLUTTER and GAGE are set to .TRUE. since only flutter (divergence) and minimum gage constraints are imposed on the optimization procedure in this example. STRESS is FALSE by default.

$OPTIMUM — R, RDC, and the initial design variable thicknesses C(1) and C(2) are set.

Input to SUBKRN

The subsonic flutter (divergence) condition requires the execution of SUBKRN.

TITLE CARD — One title card is used.

$NAM1 — The variables MACH, NK, KMAX, KMIN, and KMED are required.

Discussion of Results

Since IPRINT = 1, only the results for the initial and final design are given. In a separate run the design variables were increased by trial and error to satisfy the divergence constraint. The present run is intended to minimize the weight while still satisfying the constraint. The initial divergence altitude is 801.4 m (2629 ft) which is close, relative to the lower bound on the flutter altitude, to the critical value of 1524 m (5000 ft). This closeness is reflected in the small value of G(1) = 0.0279. The initial variable mass is 5043 kg (28.8 lb-sec^2/in.). For the final design one of the two design variables is practically zero. (The value of 3.4×10^{-5} is as close as this variable can get to zero for the last value of R.) The divergence altitude 1497 m (4911 ft) is very close to the critical value of 1524 m (5000 ft).

Langley Research Center,
National Aeronautics and Space Administration,
Hampton, Va., June 10, 1974.

APPENDIX A

DYNAMIC STORAGE ALLOCATION

Dynamic storage allocation is used in all three programs. Arrays whose sizes are problem dependent are stacked in blank common. The relative addresses of these arrays are calculated in subroutine ADDRES for program CONMAN, in subroutine SECADRS for program EXEMAN, and in subroutine KRNDRS for program SUBKRN. The addresses are stored in labeled common blocks and usually have the same name as that of the array. Thus, a typical sequence of statements in two subroutines is as follows:

```
      SUBROUTINE ALPHA
      COMMON/BLK 115/A,B,C
      COMMON/BLK 116/N
      INTEGER A,B,C
      COMMON IBG (1000000)
      CALL BETA (IBG(A), IBG(B), IBG(C), N)
      .
      .
      .
      END
      SUBROUTINE BETA (A, B, C, N)
      DIMENSION A(1), B(1), C(1)
      DO 100 I=1,N
100   C(I) = A(I)*B(I)
      RETURN
      END
```

ALPHA may be one of the control subroutines (such as the main programs) which only have the task of calling other subroutines and transmitting the addresses to them. Arrays A, B, and C are stacked in blank common, and N is a problem-dependent dimension.

The dimension of the blank common is set unrealistically high in order to insure that the Control Data Corporation 6000 system will print the available blank common length on the core map. If this available length is smaller than the needed blank common length (printed by namelist ADDRES in all programs), then the field length on the job card must be increased.

APPENDIX B

FINITE-ELEMENT STRUCTURAL ANALYSIS IN WIDOWAC

General

The basic unit in the finite-element analysis in WIDOWAC is the node rather than the individual degree of freedom. Each node has three degrees of freedom which are its displacements in the x, y, and z directions (in this order). The matrix equations of the finite-element analysis are written, therefore, in terms of 3×1 subvectors. The main advantage of this approach is that the basic operations involving 3×3 matrices are programed in longhand (that is, no DO loops) which saves on bookkeeping operations and may also be convenient for possible future parallel processing. An additional advantage is that the information on the sparsity of the matrix requires less storage space than if the formulation were based on the individual degrees of freedom.

Connectivity Matrix

The connectivity matrix C (IA in the programs) contains the information on the nonzero elements of the stiffness matrix. The element C_{ij} of the matrix C is zero if the 3×3 submatrix connecting nodes i and j is zero in the decomposed stiffness matrix (to be discussed subsequently). Otherwise, C_{ij} contains the address of the first element of the (i,j) submatrix in the one-dimensional array containing the nonzero elements of the stiffness matrix. Because the stiffness matrix is symmetric, only the lower part of the connectivity matrix needs to be generated by the programs, and this lower part is stored by rows in the one-dimensional array IA. The connectivity matrix is generated by the subroutines IADR3 and LOCAT3.

Stiffness Matrix

The stiffness matrix $[K]$ is assembled as a linear combination of its derivatives $\left[\frac{\partial K}{\partial v_i}\right]$ with respect to the design variables v_i, that is (see eq. (17) of ref. 1),

$$[K] = [K]_o + \sum_{i=1}^{NC} v_i \left[\frac{\partial K}{\partial v_i}\right]$$

where $[K]_o$ is the residual stiffness matrix obtained when all the design variables are set to zero (that is, the stiffness of the part of the structure which is not optimized). This assembly is done in subroutine PNFUNC. (See flow chart for subroutine PNFUNC in appendix E.)

The matrices $\left[K\right]_o$ and $\left[\frac{\partial K}{\partial v_i}\right]$ are generated in subroutine METHOD (see flow chart for subroutine METHOD in appendix E) by setting up the corresponding structure and calling subroutine STFMAT to calculate its stiffness matrix. Subroutine STFMAT calls the finite-element subroutines to generate the element stiffness matrices and then calls subroutine EMBED which partitions each element matrix into its 3×3 submatrices and stores them in a one-dimensional array as prescribed by the connectivity matrix.[10] Because each of the matrices $\left[K\right]_o$ and $\left[\frac{\partial K}{\partial v_i}\right]$ represents only a part of the structure, there may be leading and trailing zeros in these matrices, as stored column by column. These zeros are discarded and the remaining terms are stored by subroutine PACK in array FK following the stiffness matrix of the entire structure.

Constraints

Nodes which are completely constrained to zero displacement are deleted during the generation of the stiffness matrix. Constrained degrees of freedom at nodes which are only constrained in one or two directions (for example, only in the x direction) are not deleted in order to prevent the creation of submatrices which are not 3×3. Instead, the corresponding row and column in the stiffness matrix are set to zero and 1.0 is placed on the diagonal. The load terms corresponding to constrained degrees of freedom are set equal to zero.

Solution for Displacements

The first step in the solution of a statics problem in WIDOWAC is the Cholesky decomposition of the stiffness matrix, that is, the program finds the matrix $\left[L\right]$ so that

$$\left[K\right] = \left[L\right]\left[L\right]^T$$

where the superscript T indicates the transpose of the matrix. The decomposition is done in subroutine DECOMP. Because the $\left[K\right]$ and $\left[L\right]$ matrices are composed of 3×3 submatrices, the usual operations of the Cholesky decomposition are converted to matrix operations. The submatrices l_{im} of $\left[L\right]$ replace the submatrices k_{im} of $\left[K\right]$ in storage and are given by

$$l_{mm} = \left(k_{mm} - \sum_{\mu=1}^{m-1} l_{m\mu} l_{m\mu}\right)^{(1/2)}$$

[10] Diagonal submatrices are symmetric, and therefore only their lower part (6 numbers) is stored.

$$l_{im} = \left(k_{im} - \sum_{\mu=1}^{m-1} l_{i\mu} l_{m\mu}^{T}\right)\left(l_{mm}^{-1}\right)^{T} \qquad (i > m)$$

where the notation $l_{ii}^{(1/2)}$ is defined by

$$l_{ii} = l_{ii}^{(1/2)} l_{ii}^{(1/2)T}$$

or, in effect, $l_{ii}^{(1/2)}$ is the Cholesky decomposition of the 3×3 submatrix l_{ii}.

If a load vector $\{f\}$ is given, the displacement vector $\{w\}$ is found by solving the equation

$$[K]\{w\} = \{f\}$$

in two steps. First solve for $\{\bar{w}\}$ from

$$[L]\{\bar{w}\} = \{f\}$$

in subroutine LOWMAT (forward substitution), and then solve for $\{w\}$ from

$$[L]^{T}\{w\} = \{\bar{w}\}$$

in subroutine UPPMAT (backward substitution).

Element Stiffness and Stress Matrices

The stiffness matrices for the finite elements available in WIDOWAC are generated in subroutines called by subroutine STFMAT. These subroutines generate the element stiffness matrices in the global coordinate system. If the nodes of the finite element are numbered N_1, N_2, N_3, . . ., then the rows and columns of the element stiffness matrix are arranged in an order corresponding to $\left(x_1, y_1, z_1, x_2, y_2, z_2, x_3, y_3, z_3, \ldots\right)$.

The stresses and stress ratios are calculated in subroutines called by subroutine ELSTRES. Stress ratios are calculated by using Hill's criterion; that is, the stress ratio SR is (see section "Optimization Method")

$$SR^2 = \left(\frac{\sigma_1}{s_1}\right)^2 - \frac{\sigma_1}{s_1}\frac{\sigma_2}{s_2} + \left(\frac{\sigma_2}{s_2}\right)^2 + \left(\frac{\sigma_{12}}{s_{12}}\right)^2$$

where σ_1, σ_2, σ_{12} are the stresses and s_1, s_2, s_{12} are the corresponding stress allowables.

Rod element.- The 6×6 global stiffness matrix for the rod element is generated in subroutine ELSMAB. The stress in the rod elements is calculated in subroutine RODST. The material for the rod is assumed to be isotropic and Young's modulus is computed from the material matrix, which is read in namelist MATTER.

Triangular constant-strain membrane element.- Subroutine ELSMAT generates the 9×9 global stiffness matrix for the triangular constant strain membrane element. The element is assumed to be made of a general anisotropic material. The stresses in the element are computed in subroutine TRIST.

Rectangular membrane element.- The rectangular membrane element is composed of two sets of two triangular constant strain membrane elements. (See fig. 9, which is taken from ref. 2.) One diagonal of the quadrilateral divides the element into one set of two triangles and the other diagonal divides the quadrilateral into a second set of triangles. The 12×12 global stiffness matrix generated by subroutine ELSMAQ is the average of the 12×12 stiffness matrices generated by each set separately. Each triangle is a constant strain element and its stiffness matrix is calculated by subroutine ELSMAT.

The stresses in the quadrilateral element are calculated in subroutine QUADST as the average of the stresses in the four triangles. To provide a conservative value, the stress ratio is taken to be the maximum of all four stress ratios.

Shear web element.- The shear web element is a special element incorporating the symmetry constraints of the wing and is described in reference 1. It is defined by two nodes on the upper surface of the wing and has two additional implicit nodes on the middle surface that have been eliminated by using the constraints. The 6×6 global stiffness matrix is generated in subroutine ELSMSW, and the shear stress and stress ratio calculated in subroutine SHWEST. The material of the element is assumed to be isotropic and Young's modulus is computed from the material matrix.

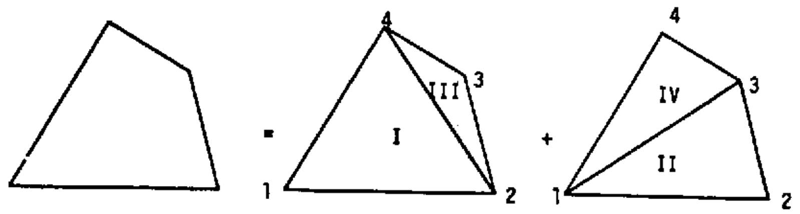


Figure 9.- Composition of quadrilateral membrane element.

APPENDIX C

VIBRATION MODE CALCULATION

The vibration problem is posed as (see eq. (18) of ref. 1)

$$\left[[K] - \omega^2[M]\right]\{w\} = \{0\}$$

where $[M]$ is the mass matrix which in WIDOWAC is assumed to be a lumped mass matrix, that is, diagonal. The problem is converted by the transformation

$$\{\bar{w}\} = [M]^{1/2}\{w\}$$

into a standard eigenvalue problem

$$\left[[B] - \frac{1}{\omega^2}[I]\right]\{\bar{w}\} = \{0\}$$

where $[I]$ is the identity matrix and

$$[B] = [M]^{1/2}[K]^{-1}[M]^{1/2}$$

This treatment is valid only in the absence of rigid-body degrees of freedom. Treatment of rigid-body modes is discussed subsequently. The eigenvectors $\{\bar{w}\}$ of $[B]$ are orthonormal with respect to the unit matrix, and $\{w\}$ is then calculated from $\{\bar{w}\}$

$$\{w\} = [M]^{-1/2}\{\bar{w}\}$$

so that the vibration modes are orthonormal with respect to the mass matrix.

The order of the vibration problem is reduced because of zero inertial forces in the x and y directions.[11] The eigenvalues and eigenvectors of the matrix $[B]$ are then calculated by a simultaneous iteration technique. (See ref. 3.) The iteration is executed on a number (NVEC) of vectors which is larger than the number of desired modes (NEIG) in order to speed up the convergence of the desired modes.

The calculation of the vibration modes is directed by subroutine VIBRAT. This subroutine calls subroutine EIGINT the first time the modes are computed to initialize a trial set of vectors. Subroutine EIJEN1 is then called to calculate the eigenvalues of $[B]$, and

[11]This is due to the symmetry of the structure. All the mass is assumed to be in the wing midplane, and there is no in-plane displacement in this plane.

VIBRAT transforms these eigenvectors into the vibration modes. The vibration modes are used for a flutter analysis by subroutine FLUTTER and then subroutine PNFUNC transforms them back into the eigenvectors of $[B]$ for use in the next analysis as the trial vectors.

The basic operation in the simultaneous iteration is the multiplication of the matrix $[B]$ by the trial set of vectors. This operation presents two problems:

(1) The matrix $[K]^{-1}$ is not available, but only the decomposition $[L]$. (See section on finite-element analysis, solution for displacements.)

(2) When rigid-body degrees of freedom are present, the matrix $[K]$ is singular.

To take care of this problem the stiffness matrix of an artificially constrained structure (see appendix B) is used instead of the stiffness matrix of the unconstrained structure.

The procedure for multiplying the matrix $[B]$ by a vector is as follows:

(1) $\{w_1\} = [M]^{1/2}\{w\}$

(2) $\{w_2\} = [K]^{-1}\{w_1\}$

(3) $\{w_3\} = [M]^{1/2}\{w_2\} = [B]\{w\}$

In step (1), the vector $\{w\}$ is available from the previous analysis (or subroutine EIGINT) in a reduced form containing only the z entries. It is multiplied by $[M]^{1/2}$ and simultaneously expanded by adding zeros for the x,y displacements (subroutine EXPAND).

Step (2) solves the system $[K]\{w_2\} = \{w_1\}$ for $\{w_2\}$.

Step (3) orthogonalizes $\{w_2\}$ with respect to the rigid-body modes (thus, the artificial constraints are removed) and multiplies it by $[M]^{1/2}$. Simultaneously, the x,y displacements are removed and $\{w_3\}$ is obtained (subroutine CNTRCT).

APPENDIX D

FLUTTER ANALYSIS

Flutter Equation

The natural vibration modes of the wing structure are used as generalized coordinates in the formulation of the flutter problem. In this modal formulation, the flutter equation is (see eqs. (11) and (12) of ref. 1)

$$\left[\omega^2 - \omega_k^2\left(1 + ig_{s,k} + ig\right)\right]M_k c_k + \sum_{j=1}^{n} A_{kj}c_j = 0 \qquad (k = 1(1)n) \tag{D1}$$

where n (NEIG in the programs) is the number of vibration modes, ω_k, $g_{s,k}$, M_k, and c_k are the frequency, structural damping coefficient, generalized mass, and generalized coordinate (usually complex), respectively, associated with the kth mode. In WIDOWAC the vibration modes are normalized so that $M_k \equiv 1$, and it is assumed the $g_{s,k} = g_s$ independent of k. Note that equation (D1) represents a transcendental eigenproblem in the unknown flutter frequency ω, flutter Mach number M, and flutter altitude H. The quantity g is an artificial damping parameter introduced in the program so that linear eigenvalue solution techniques can be used. The complex generalized aerodynamic force is

$$A_{kj} = \iint_S \Delta p^j(x,y)z^k(x,y)dS \tag{D2}$$

where z^k and Δp^j are the z displacements associated with the kth mode, and the pressure differential associated with the jth mode, respectively, and S is the wing area. The flutter mode is given by $\sum_{j=1}^{n} c_j z^k$.

Calculation of the Generalized Aerodynamic Forces

Piston theory aerodynamics.- For piston theory aerodynamics, the pressure differential Δp^j is given as (see ref. 1, p. 11)

$$\Delta p^j = P_V^j V + iP_\omega^j \omega + iP_{V\omega} V\omega + P_{V^2} V^2 \tag{D3}$$

where

$$\left.\begin{aligned}
P_V^j &= -2\rho a \frac{\partial z^j}{\partial x} \\
P_\omega^j &= -2\rho a z^j \\
P_{V\omega}^j &= -\rho\left(\frac{\gamma + 1}{2}\right)\frac{\partial h}{\partial x} z^j \\
P_{V^2}^j &= -\rho\left(\frac{\gamma + 1}{2}\right)\frac{\partial h}{\partial x}\frac{\partial z^j}{\partial x}
\end{aligned}\right\} \tag{D4}$$

and ρ is the mass density, γ is the specific heat ratio of air, a is the speed of sound, and h is the airfoil local depth.

The generalized aerodynamic forces are then expressed as

$$A_{kj} = A_{kj}^V V + A_{kj}^{V^2} V^2 + i\left(A_{kj}^\omega \omega + A_{kj}^{V\omega} V\omega\right) \tag{D5}$$

where

$$\left.\begin{aligned}
A_{kj}^V &= \iint_S P_V^j z^k dS \\
A_{kj}^{V^2} &= \iint_S P_{V^2}^j z^k dS \\
A_{kj}^\omega &= \iint_S P_\omega^j z^k dS \\
A_{kj}^{V\omega} &= \iint_S P_{V\omega}^j z^k dS
\end{aligned}\right\} \tag{D6}$$

Calculation of the matrices A_{kj}^V, $A_{kj}^{V^2}$, A_{kj}^ω, $A_{kj}^{V\omega}$ is done in subroutine AERMAT where these matrices are called VMAT, V2MAT, OMMAT, and VOMAT, respectively.

Subsonic kernel function aerodynamics.- The subsonic kernel function aerodynamics is based on reference 7. The implementation of the method of reference 7 into WIDOWAC is an adaptation of a computer program written by Robert N. Demarais of NASA Langley Research Center. The pressure differential in equation (D2) is found from the downwash-pressure integral (eq. (1) of ref. 7)

$$\frac{\bar{w}(X,Y)}{V} = \frac{b_o \ell}{8\pi} \int_{-1}^{1} \int_{-1}^{1} \frac{\Delta p(\xi,\eta)}{q} K\left[M, k(X - \xi), k(Y - \eta)\right] \frac{b(\eta)}{b_o} d\xi \, d\eta \tag{D7}$$

where

$$\left.\begin{aligned} X &= \frac{x - x_m(y)}{b(y)} \\ Y &= \frac{y}{\ell} \\ \xi &= \frac{\bar{\xi} - x_m(\bar{\eta})}{b(\bar{\eta})} \\ \eta &= \frac{\bar{\eta}}{\ell} \end{aligned}\right\} \tag{D8}$$

in which b_o is the root semichord, ℓ is the semispan, and $x_m(y)$ and $b(y)$ are the x coordinate of the midchord line and the streamwise semichord at a spanwise station y, respectively. The dimensional coordinates $\bar{\xi},\bar{\eta}$ correspond to the dimensional quantities x,y, respectively. The downwash which is the left-hand side of equation (D7) is

$$\frac{\bar{w}(X,Y)}{V} = \left(\frac{\partial}{\partial X} + ik\right) \frac{h(X,Y)}{b_o} \tag{D9}$$

The complex amplitude of the assumed pressure distribution is

$$\Delta p(\xi,\eta) = 8\pi q s \frac{b_o}{b(\eta)} \sqrt{1 - \eta^2} \sqrt{\frac{1 - \xi}{1 + \xi}} \sum_{i=1}^{NS} \sum_{j=1}^{NYC} a_{ij} U_{2j-1}(\eta)\, u_{i-1}(\xi) \tag{D10}$$

where q is the dynamic pressure, $s = \frac{\ell}{b_o}$

$$U_k(\eta) = \frac{\sin\left[(k + 1)\cos^{-1}\eta\right]}{\sin\left(\frac{1}{2}\cos^{-1}\eta\right)} \tag{D11}$$

$$u_k(\xi) = \frac{\sin\left[\left(k + \frac{1}{2}\right)\cos^{-1}\xi\right]}{\sin\left(\frac{1}{2}\cos^{-1}\xi\right)} \tag{D12}$$

and the a_{ij} are the unknown complex coefficients to be determined by solution of equation (D7).

In WIDOWAC U_k and u_k are not calculated directly from equations (D11) and (D12), but from the recursive relation

$$Z_{n+1} = 2\xi Z_n - Z_{n-1} \tag{D13}$$

where Z_n is either $u_n(\xi)$ or $U_n(\xi)$. For the sake of brevity, equation (D10) may be written as

$$\Delta p(\xi,\eta) = 8\pi qs \frac{b_o}{b(\eta)} \sum_{k=1}^{NP} e_k u_k(\xi,\eta) \tag{D14}$$

where

$$u_k(\xi,\eta) = \sqrt{1 - \eta^2}\sqrt{\frac{1 - \xi}{1 + \xi}}U_{2j-2}(\eta)\, u_{i-1}(\xi) \tag{D15}$$

and

$$\left.\begin{aligned} k &= (i - 1)NYC + j \\ NP &= (NS)(NYC) \end{aligned}\right\} \tag{D16}$$

then from equation (D7) and equation (D14)

$$\frac{\overline{w}(X,Y)}{V} = \sum_{k=1}^{NP} e_k B_k(X,Y,M,k) \tag{D17}$$

where the pressure-kernel integrals are

$$B_k = b_o^2 s^2 \int_{-1}^{1}\int_{-1}^{1} u_k(\xi,\eta) K\left[M,k(X - \xi),\ k(Y - \eta)\right] d\xi\, d\eta \tag{D18}$$

To solve for the pressure coefficients e_k, equation (D17) is enforced at collocation points $\left(X_t,Y_t\right)$ where $t = 1(1)NP$. The resulting equations are written in matrix form as

$$\overline{W} = b_o \overline{B}\overline{E} \tag{D19}$$

where the elements of the matrices $\overline{W}$, $\overline{B}$, and $\overline{E}$ are

$$W_{tj} = \left(\frac{\partial}{\partial X} + ik\right)h^j\Big|_{X_t,Y_t}$$

$$B_{tk} = B_k\left(X_t,Y_t,M,k\right) \tag{D20}$$

$$E_{kj} = e_k^j$$

The matrix $\overline{B}$ is independent of the modes and is calculated and inverted once for a number of reduced frequencies in program SUBKRN. In terms of the pressure coefficients, the generalized aerodynamic forces in equation (D2) are given as

$$A_{ij} = 8\pi q b_o^2 s^2 \sum_{k=1}^{NP} P_{ik}E_{kj} \tag{D21}$$

where the force-quadrature coefficients P_{ik} are

$$P_{ik} = \int_{-1}^{1}\int_{-1}^{1} u_k(\xi,\eta)h^i(\xi,\eta)d\xi\, d\eta \tag{D22}$$

From equation (D19),

$$\overline{E} = \frac{1}{b_o}\overline{B}^{-1}\overline{W} \tag{D23}$$

so that

$$A_{ij} = 8\pi q b_o s^2 Q_{ij} \tag{D24}$$

where

$$\left[Q_{ij}\right] = \overline{P}\,\overline{B}^{-1}\overline{W} \tag{D25}$$

The force-quadrature coefficients are calculated in subroutine FQC, and the product $\overline{P}\,\overline{B}^{-1}\overline{W}$ in subroutine MAIN.

Solution of the Flutter Equation

The flutter problem as posed in equation (D1) is a nonlinear eigenvalue problem in the frequency, speed, and altitude. Usually, either the speed or the altitude is kept fixed and equation (D1) is solved for the other two parameters.

Supersonic condition.- For a supersonic condition the user specifies the altitude indirectly by putting in the value of air density and speed of sound. Equation (D1) is solved by the determinant method. This solution involves a search for a combination of speed V and frequency ω which makes the determinant of equation (D1) vanish. In this case, there is no need for the artificial damping parameter g in equation (D1) and it is set to zero.

For an optimization run, WIDOWAC uses Newton-Raphson iteration to seek the point in the V,ω plane where the determinant vanishes. This iterative method is likely to converge only when started close to the solution and it is not used, therefore, for an analysis run. In an analysis run, the program evaluates the flutter determinant at a grid of values of V and ω. The user has to look for points in the grid where both the real and imaginary parts of the determinant change signs simultaneously.

Subsonic condition.- For a subsonic condition, the user specifies the Mach number, and equation (D1) is solved for the flutter frequency and altitude. Equation (D1) is rewritten in nondimensional form

$$\left[\left(\frac{\omega b_o}{V}\right)^2 - \left(\frac{\omega_k b_o}{V}\right)^2\left(1 + ig + ig_s\right)\right]c_k + \Delta_p \sum_{j=1}^{n} Q_{kj}c_j = 0 \qquad (k = 1(1)n) \qquad \text{(D26)}$$

where $n = \text{NEIG}$ and

$$\Delta_p = 4\pi\rho b_o^3 s^2 \qquad \text{(D27)}$$

Define

$$\Omega = \left(\frac{\omega_r b_o}{V}\right)^2\left(1 + ig + ig_s\right) \qquad \text{(D28)}$$

where ω_r is a reference frequency; then equation (D26) becomes

$$\sum_{j=1}^{n}\left(C_{ij} - \delta_{ij}\Omega\right)c_j = 0 \qquad (i = 1(1)n) \qquad \text{(D29)}$$

where δ_{ij} is the Kronecker delta and

$$C_{ij} = \left(\frac{\omega_r}{\omega_i}\right)^2 \left(\Delta_p Q_{ij} + \delta_{ij} k^2\right) \tag{D30}$$

Equation (D29) is a linear eigenvalue problem in Ω. A flutter solution is obtained for values of Ω such that $g = 0$, where g is calculated from equation (D28). In an analysis run, equation (D29) is solved for a series of reduced frequency (k) values and the values of V and g are calculated from Ω as defined by equation (D28) (V,g method).

The generalized aerodynamic force matrices are calculated at NK k values and then interpolated at IGAIN - 1 points in each interval DK. The series of reduced frequency (k) values is computed by the expression

$$k = \text{KMED} - \frac{R_3 \text{DK}}{R_2(1 - \text{DK}) + R_1(1 + \text{DK})}$$

where

$$\text{DK} = -1 + \frac{2(i - 1 + \epsilon)}{(\text{NK} - 1 + \epsilon)} \qquad (i = 1(1)\text{NK})$$

$$R_1 = \text{KMAX} - \text{KMED} + \epsilon$$

$$R_2 = \text{KMED} - \text{KMIN} + \epsilon$$

$$R_3 = 2R_1R_2$$

$$\epsilon = 10^{-15}$$

The flutter crossing is the lowest value of V. This V,g solution is first obtained at an altitude specified by the user. Generally, the flutter speed V and Mach number M are not compatible with the speed of sound specified by the standard atmosphere.[12] WIDOWAC then tries to find the matched altitude by assuming that the flutter dynamic pressure is independent of altitude as described in the section "Flutter Calculation."

---

[12] If different atmospheric conditions are desired, subroutine AT62 should be replaced by a subroutine written for these atmospheric conditions.

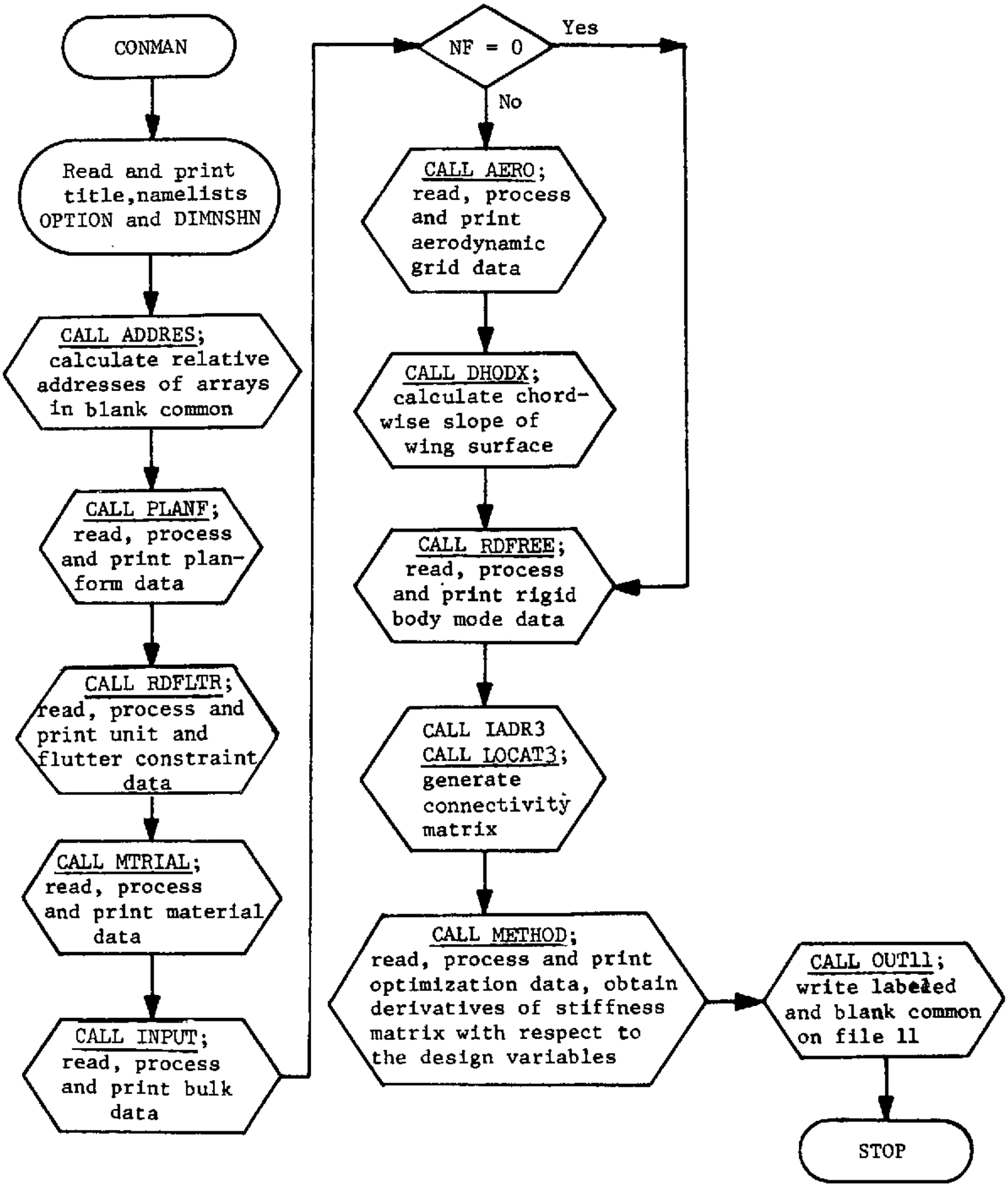
In an optimization run, the determinant method described in the section "Supersonic Condition" is used. The determinant of equation (D29) is driven to zero by changing the frequency and the altitude.

APPENDIX E

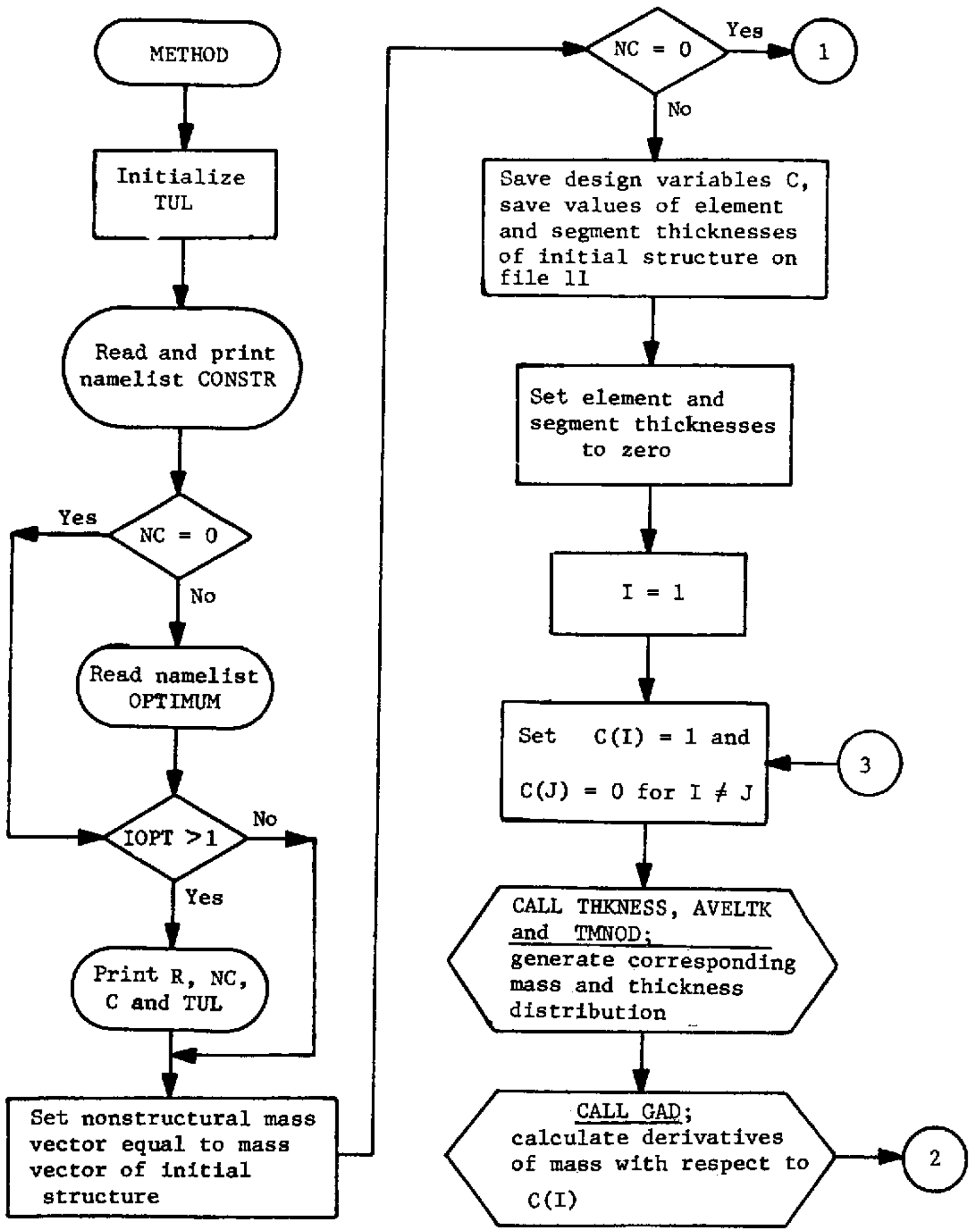
FLOW CHARTS

The flow charts used for the various programs are presented in this appendix.

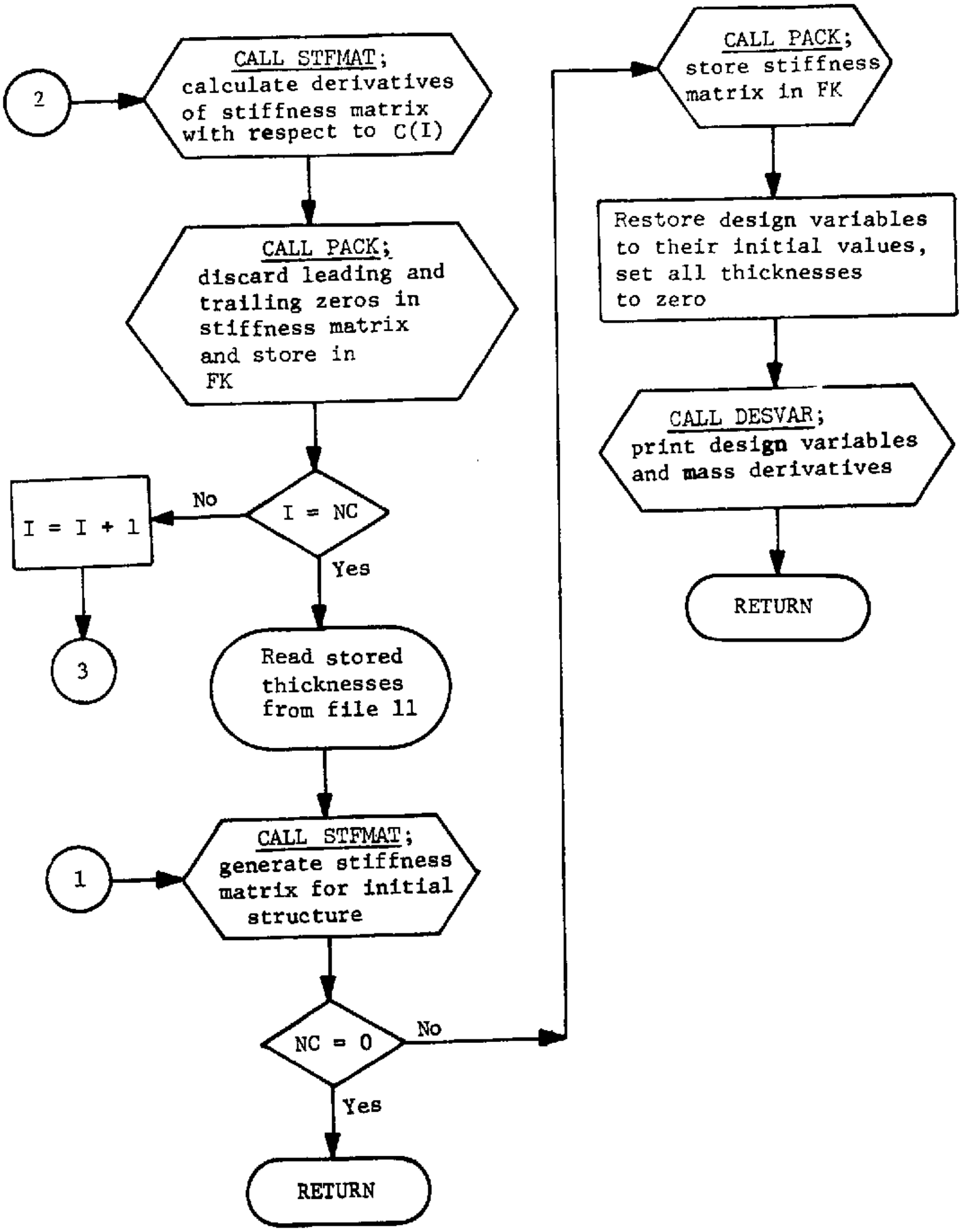
Flow Chart of Program CONMAN.



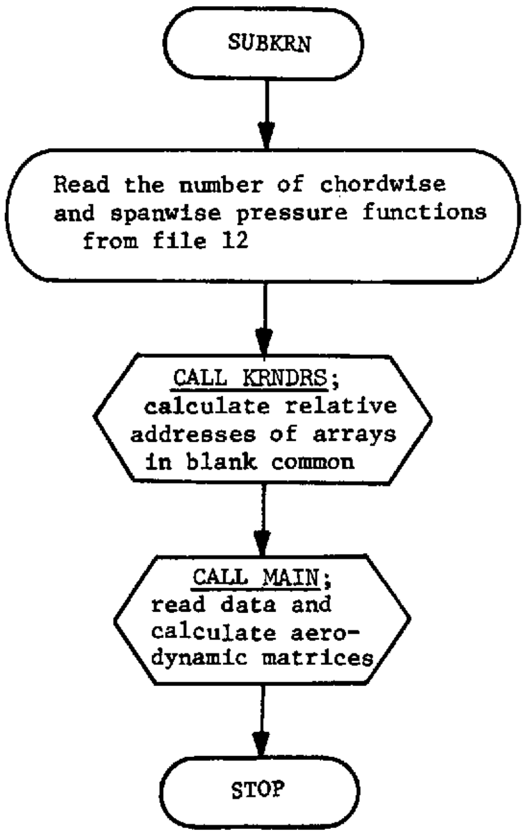
Flow Chart of Subroutine METHOD.



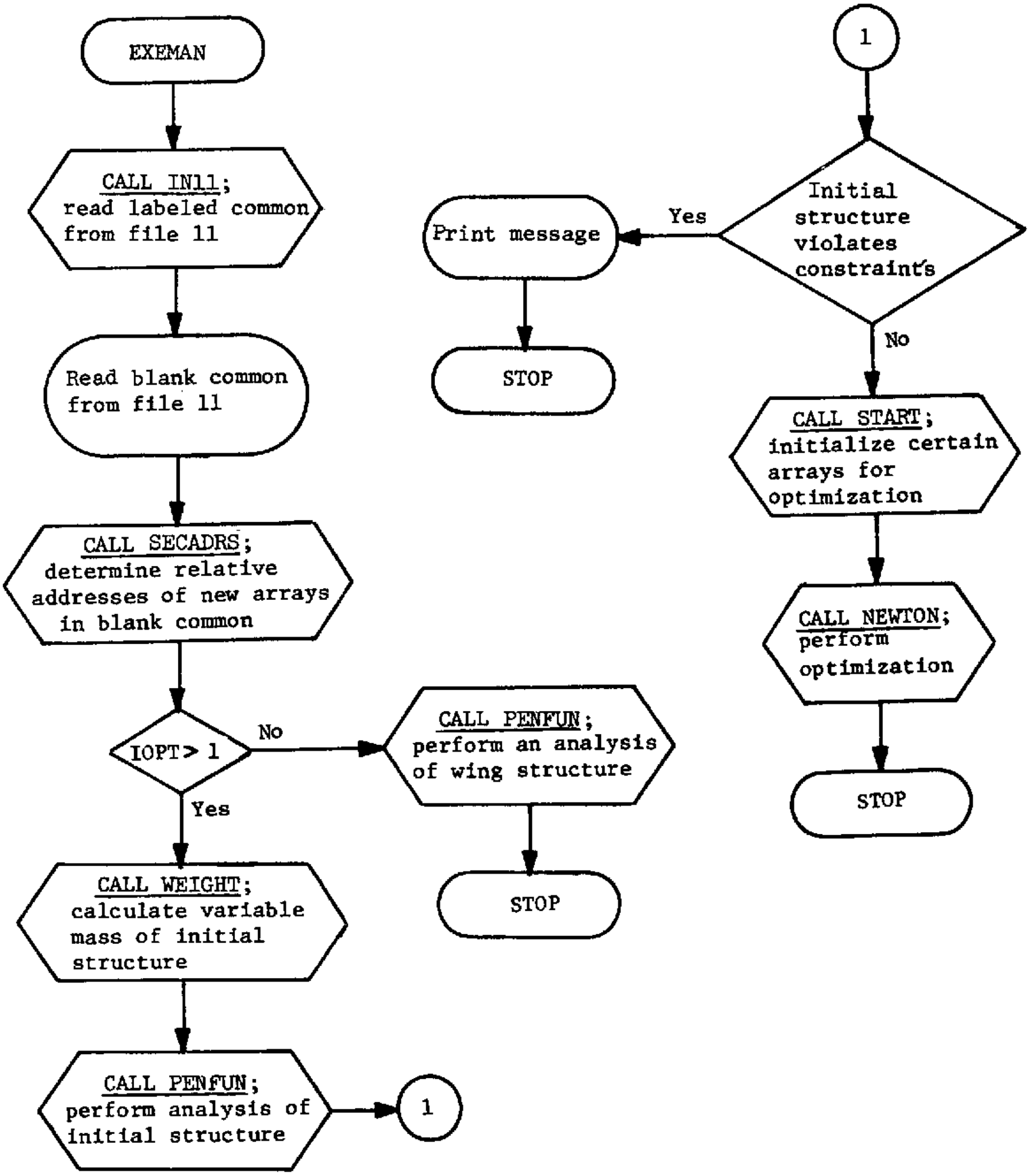
Flow Chart of Subroutine METHOD – Concluded.



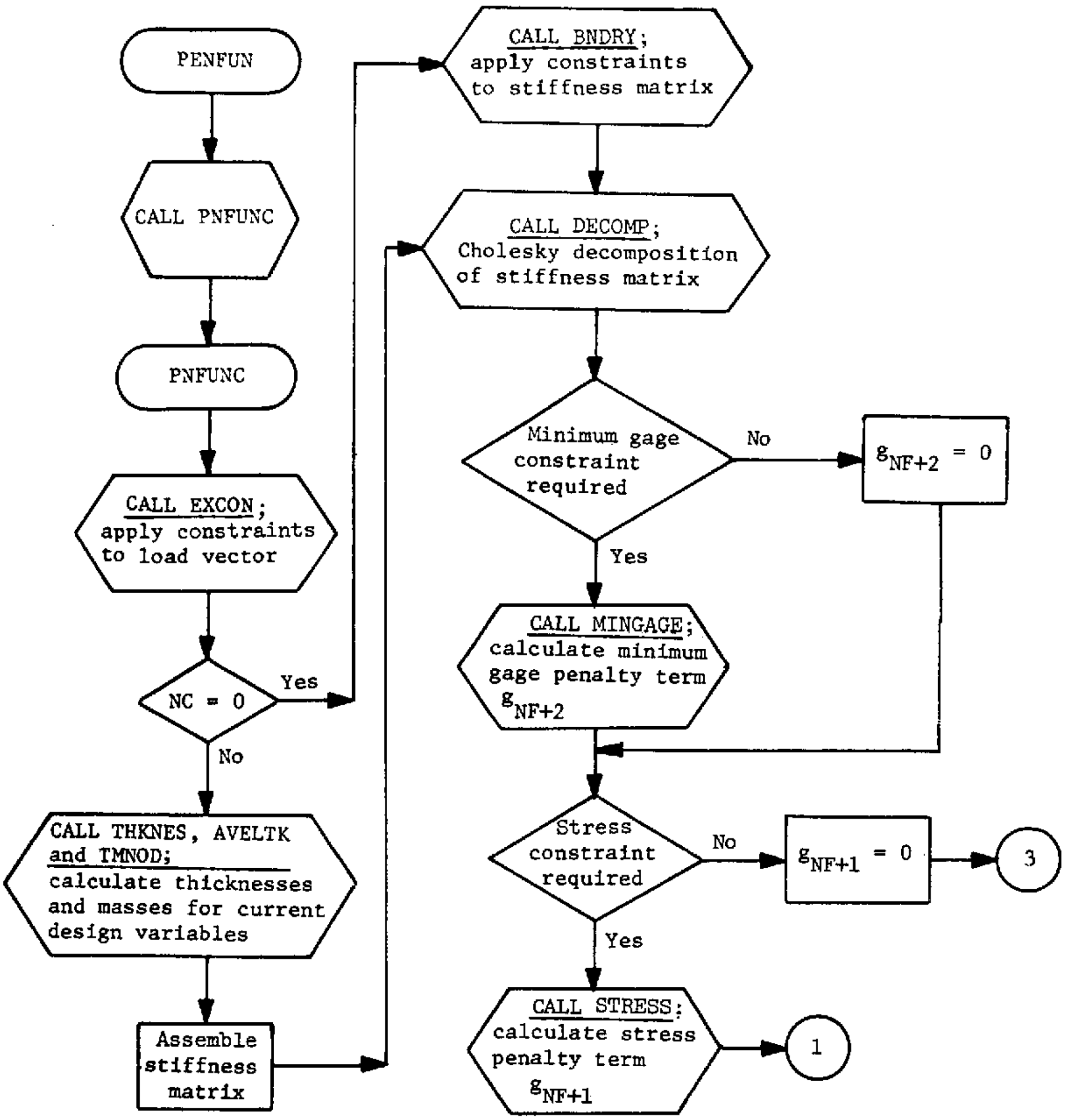
Flow Chart of Program SUBKRN.



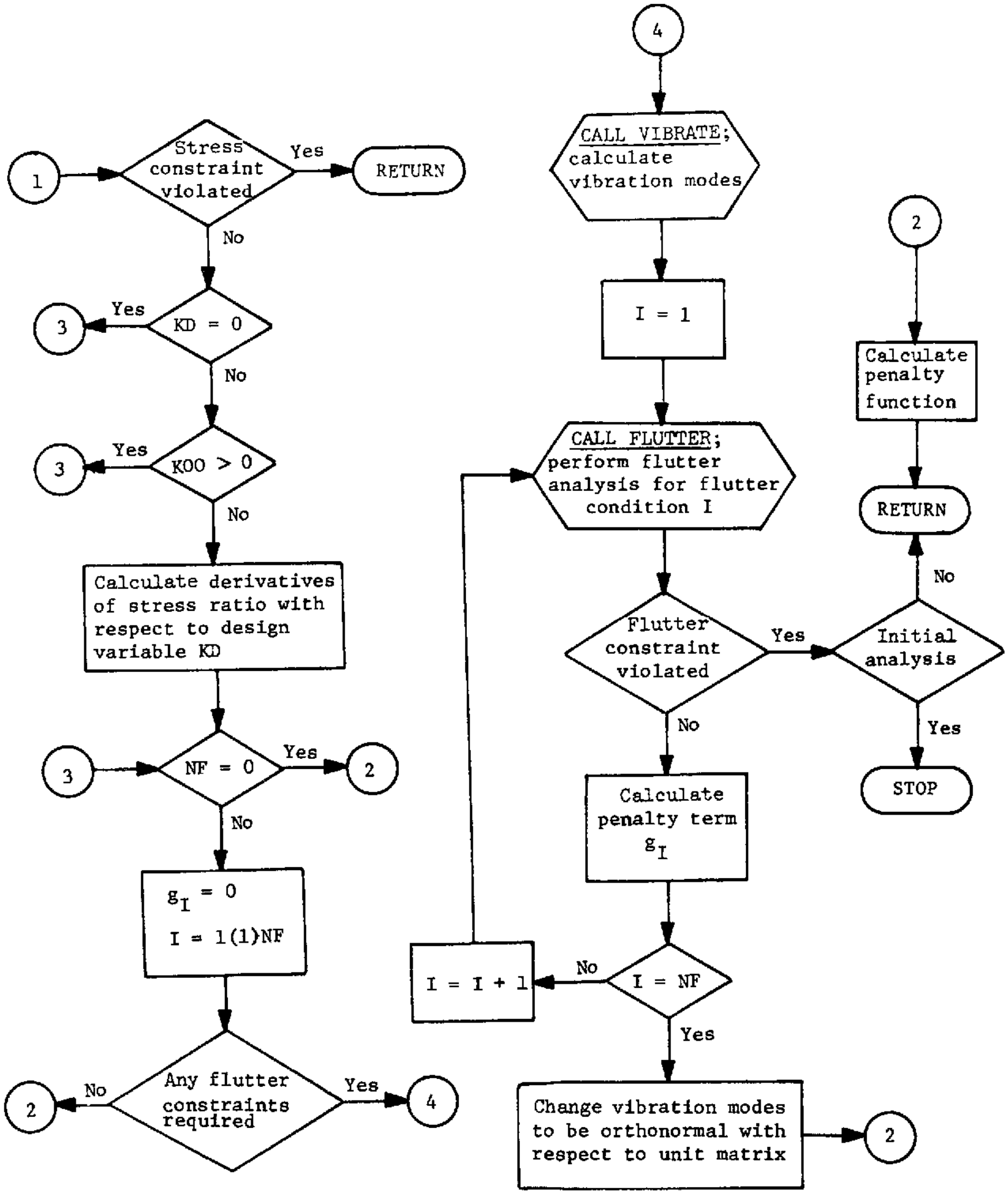
Flow Chart of Program EXEMAN.



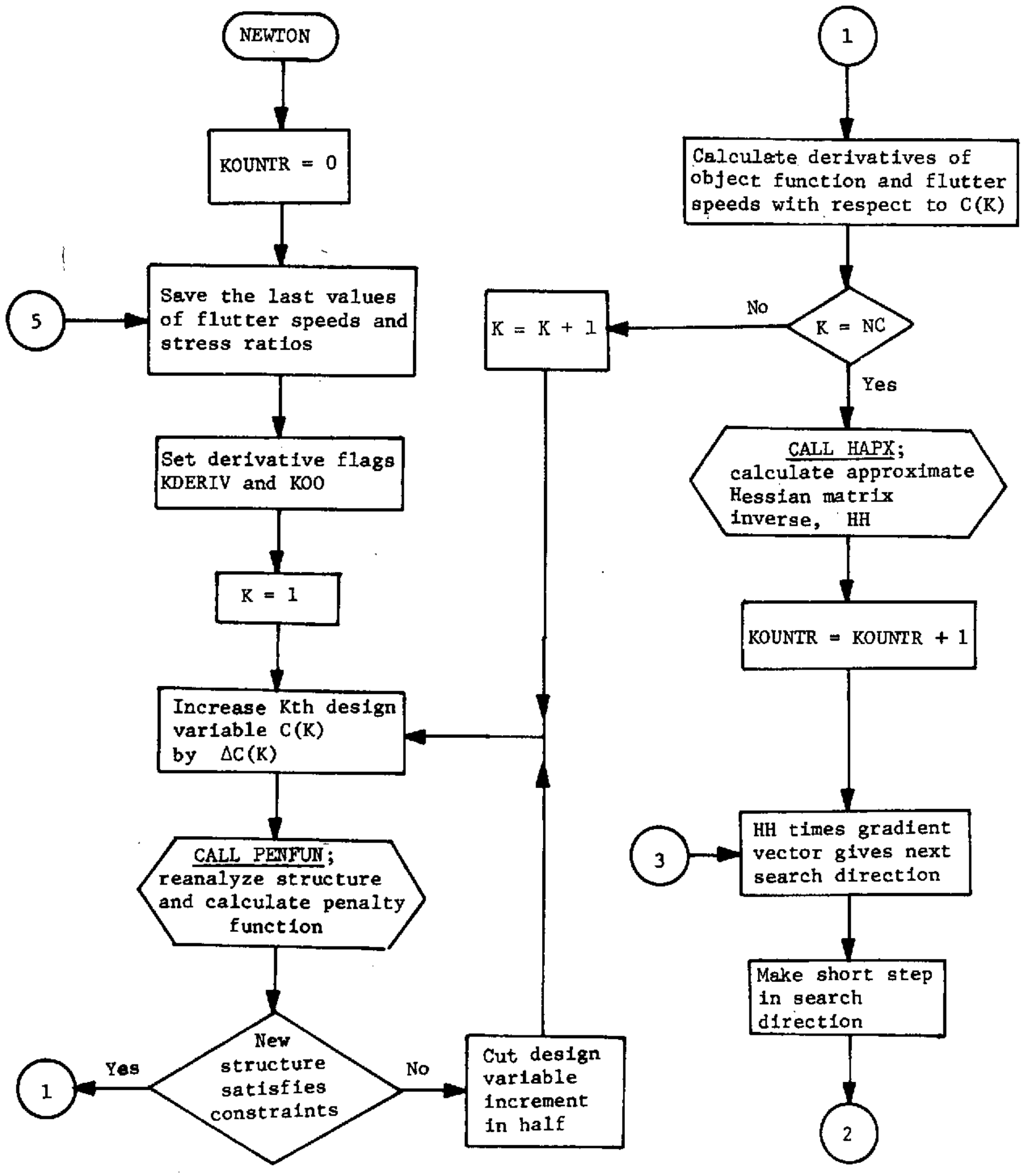
Flow Chart of Subroutines PENFUN and PNFUNC.



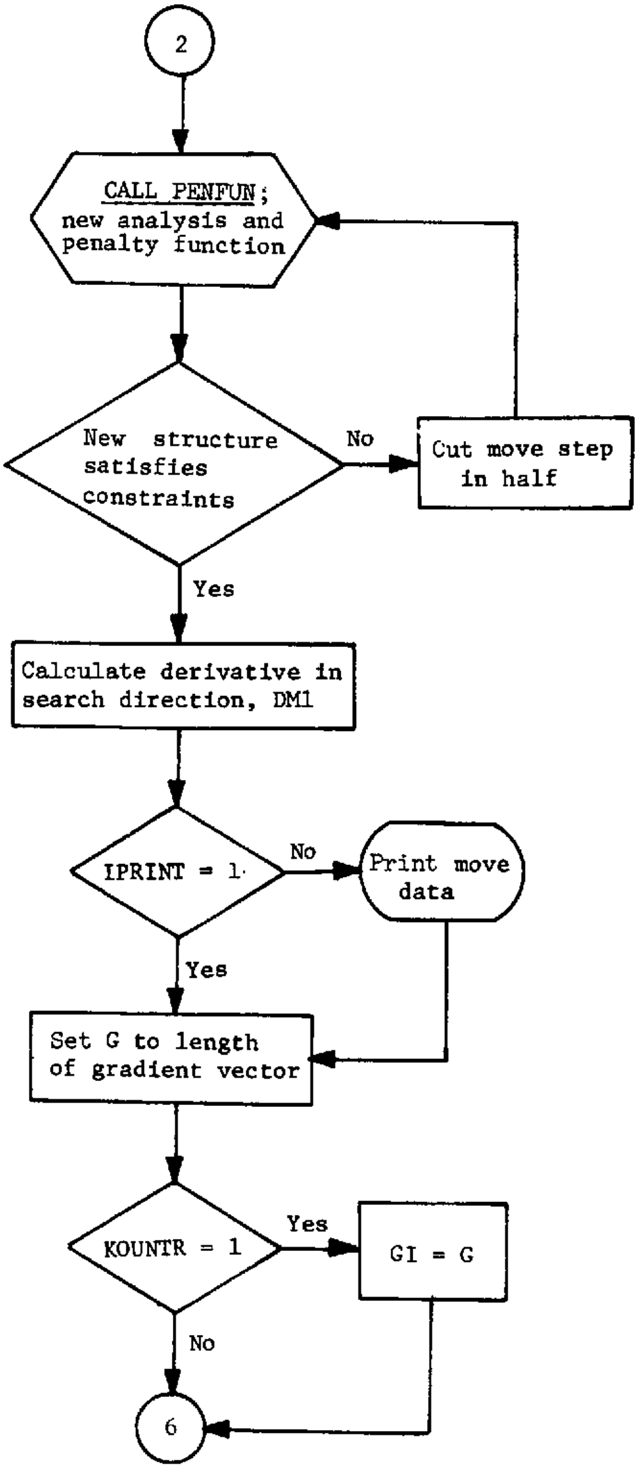
Flow Chart of Subroutines PENFUN and PNFUNC – Concluded.



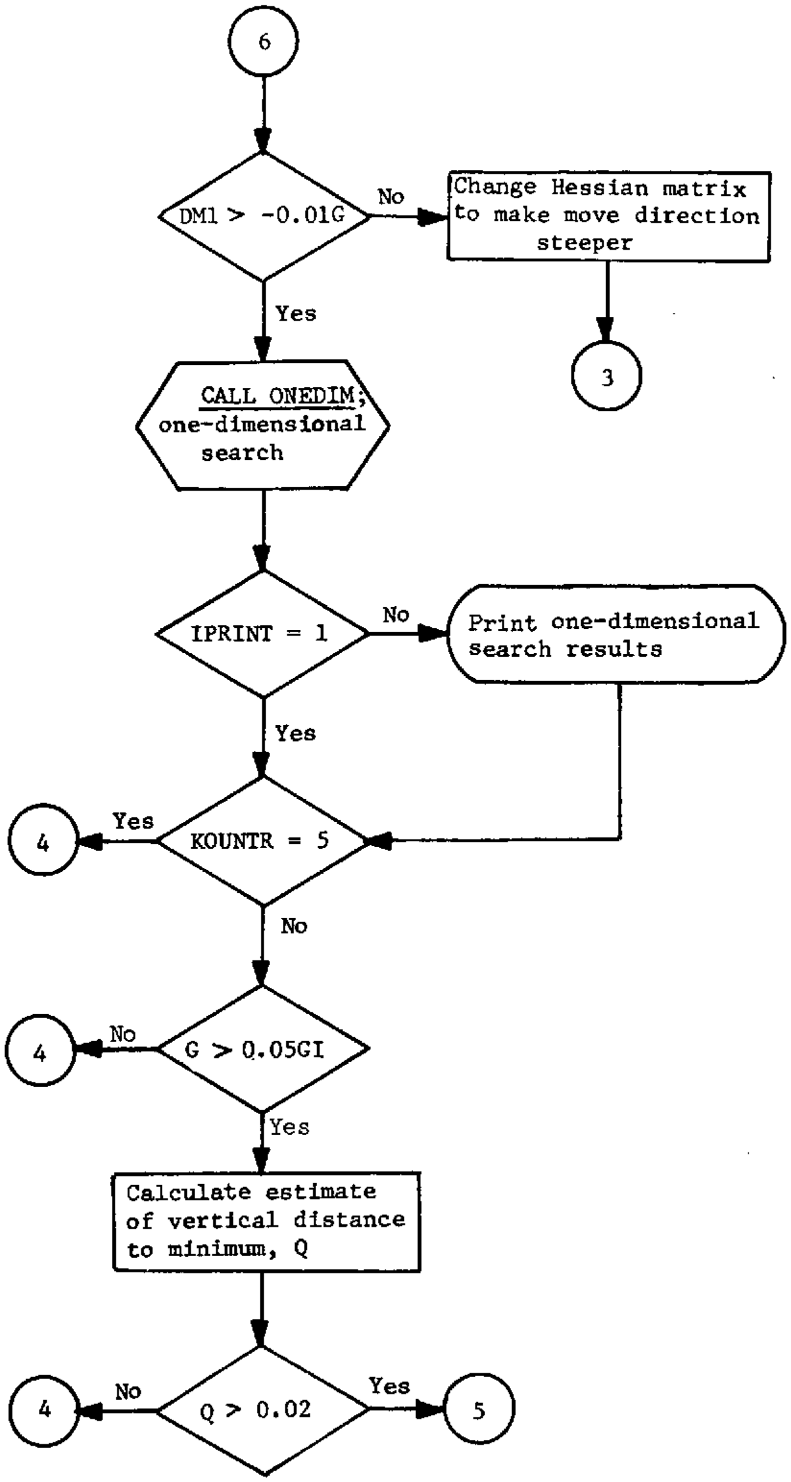
Flow Chart of Subroutine NEWTON.



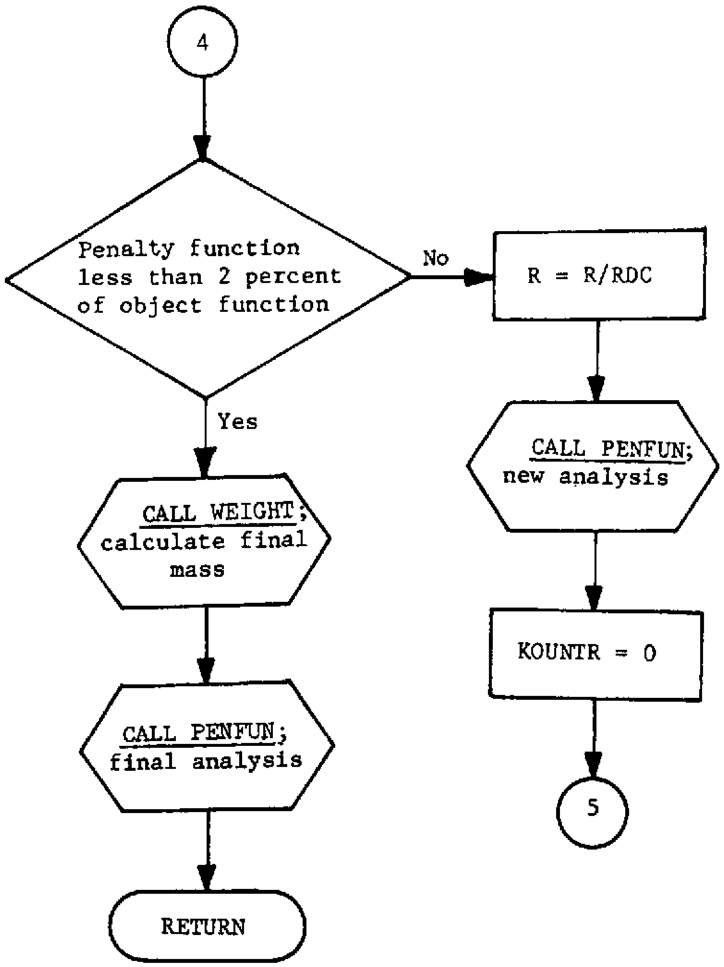
Flow Chart of Subroutine NEWTON – Continued.



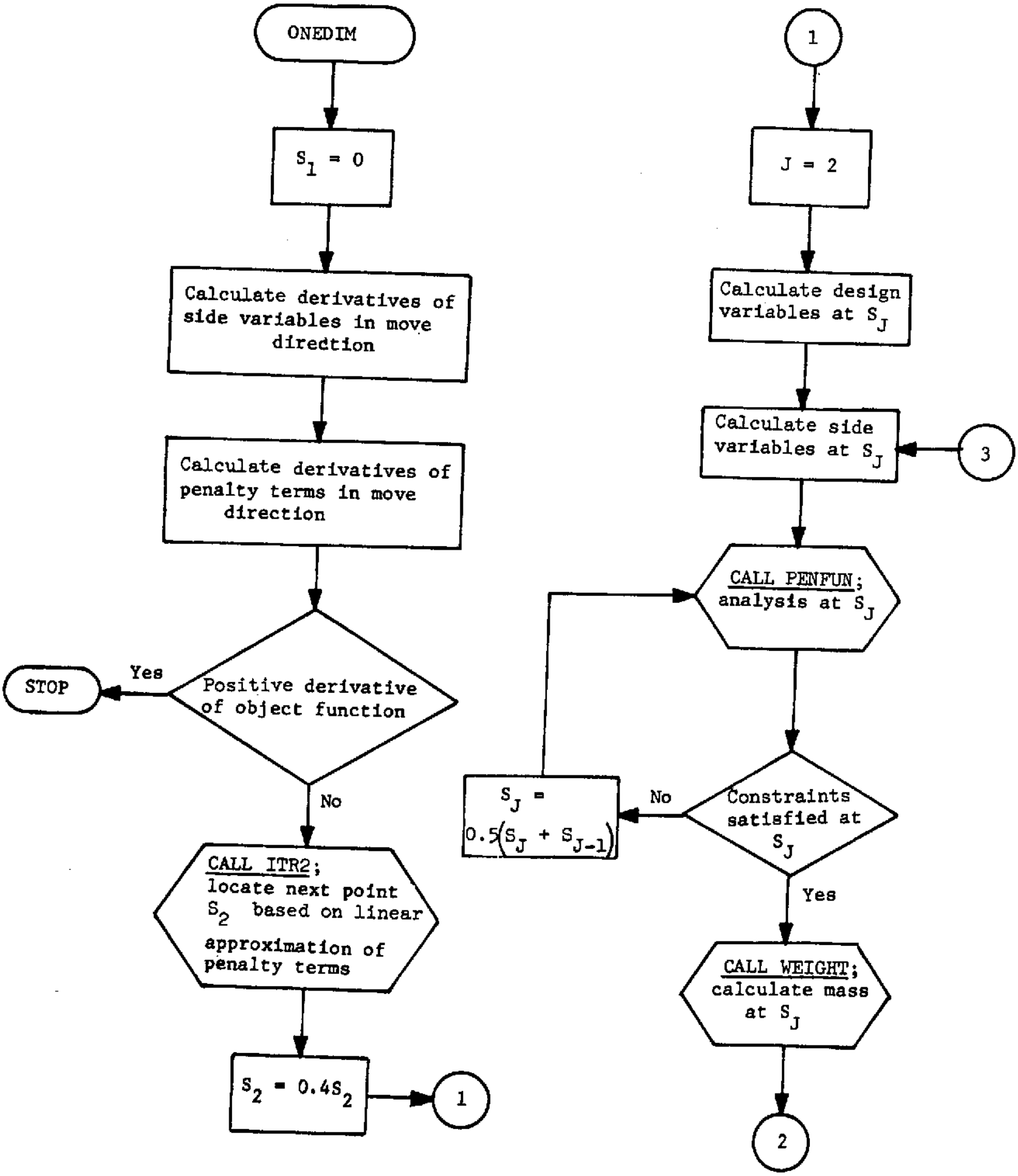
Flow Chart of Subroutine NEWTON – Continued.



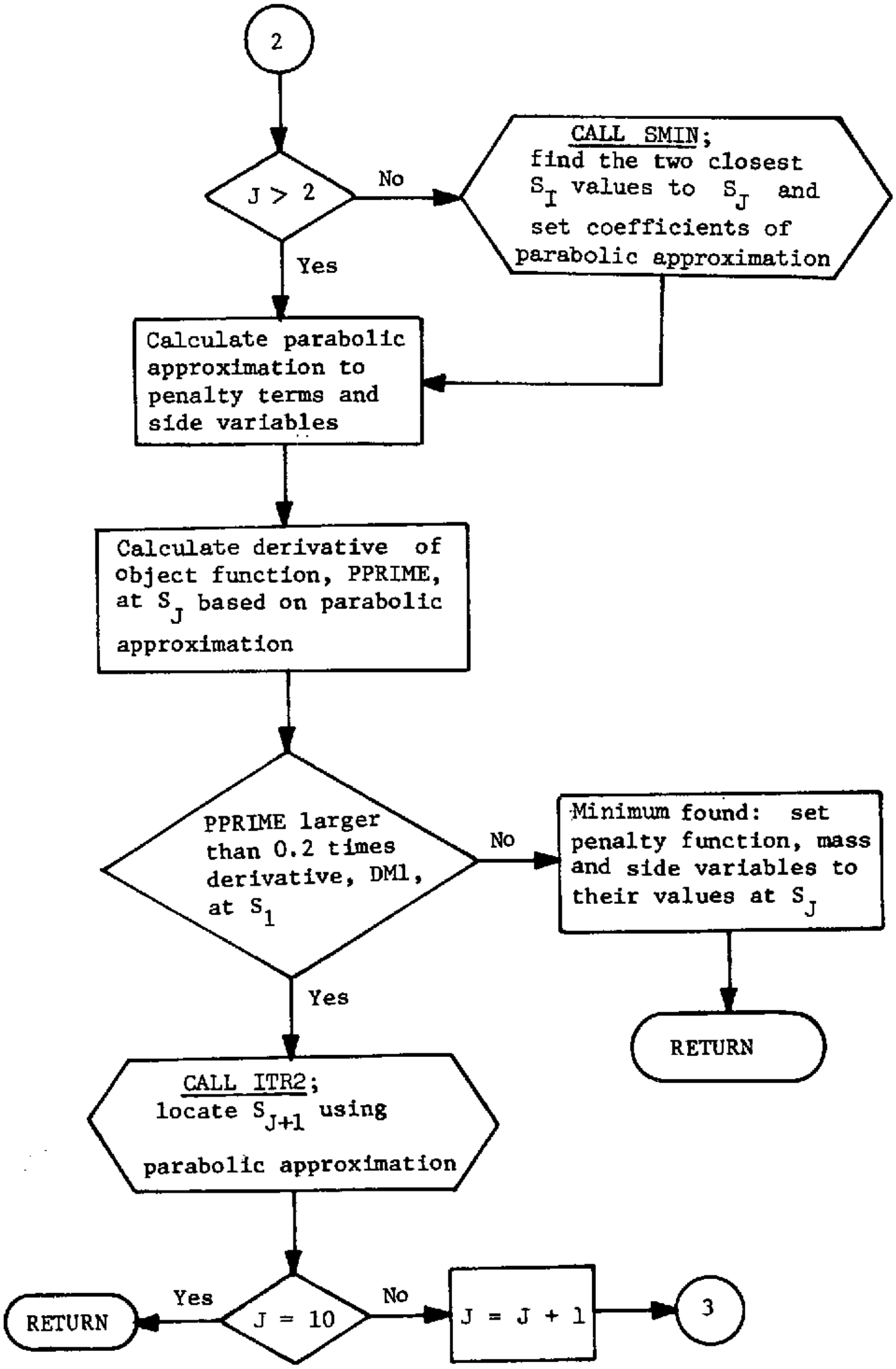
Flow Chart of Subroutine NEWTON – Concluded.



Flow Chart of Subroutine ONEDIM.



Flow Chart of Subroutine ONEDIM – Concluded.



APPENDIX F

INPUT DATA AND PROGRAM OUTPUT FOR THE EXAMPLE PROBLEMS

The input data and program output for examples 1, 2, and 3 are given in this appendix.

Example 1 Input

```
1  EXAMPLE  1 FULL DEPTH SANDWICH WING ANALYSIS RUN
 $OPTION  IPRINT=2, IZCOR=0, IOPT=1, IPUNCH=0  $
 $DIMNSHN NEL=100, NNOD=38, NTSEG=6, NSN=20, NEIG=5, NVEC=9, NMAT=2, NDV=0,
  NOC=7,  NF=3, NYS=7, NYC=4, NS=4, NXP=10, NFREE=0  $
 $WNGEOM  AR=2.5530,AREA=1.131610E6,ANGLE1=50.5 , TAPER= .127005, DR=0.03 $
 $UNIT LUNIT=.0254 ,MUNIT=175.1268340,MNORM=1 ,G=386.4 $
 $FLUTER  HINIT=-1524.,NK=10,
     KFK=2, HCR=1524.,MACH=.6, KMAX=2., KMIN=0., KMED=1., REF=100.$
 $FLUTER HINIT= 3048.,                    NK=12, KFK=2, MACH=.75, KMAX=2.5, KMIN=0.,
     KMED=1., REF=100., NTAPE=1$
 $FLUTER OMINIT=0., DELOM=1., OMFIN=20., VINIT=15000., DELV=1000., VFIN=40000.,
     A=12204., RHOA=5.14E-6, GAMA=1.4, KFK=1$
 $MATTER                     RHO=4.14E-4, SIGMA1=1.25E5, SIGMA2=1.25E5,
      E1=1.64E7, E2=1.64E7, U21=.3, U12=.63075E7,  SIGMA12=7.217E4  $
 $MATTER E=1.64E7, U=.3, SIGMA1=1.25E5, SIGMA2=1.25E5, SIGMA12=7.217E4, IFL=1 $
    1       .03
    2       .15
    3       .28
    4       .48
    5       .64
    6       .88
    7      1.12
    8       .15       .12
    9       .28       .12
   10       .28       .25
   11       .38       .25
   12       .48       .25
   13       .64       .25
   14       .88       .25
   15      1.12       .25
   16       .38       .35
   17       .48       .35
   18       .48       .45
   19       .64       .45
   20       .88       .45
   21      1.12       .45
   22       .64       .61
   23       .77       .61
   24       .88       .61
   25      1.12       .61
   26       .77       .74
   27       .88       .74
   28       .96       .74
   29      1.12       .74
   30       .88       .85
   31       .96       .85
   32      1.03       .85
   33      1.12       .85
   34       .96       .93
   35      1.03       .93
```

	36		1.12		.93			
	37		1.03		1.00			
1	38		1.12		1.00		1031.132	857.
	1	2	1	2	8	.027	1 16.0	
	2		2	3	9			
	3		2	9	8			
	4		8	9	10			
	5		3	4	9			
	6		9	4	11			
	7		9	11	[illegible]			
	8		4	12	11			
	9		10	11	16			
	10		11	12	15			
	11		12	17	16			
	12		16	17	18			
	13		4	5	13			
	14		4	13	12			
	15		12	13	17			
	16		13	19	17			
	17		17	19	18			
	18		18	19	22			
	19		5	6	14			
	20		5	14	13			
	21		13	14	20			
	22		13	20	19			
	23		19	20	23			
	24		20	24	23			
	25		19	23	22			
	26		22	23	26			
	27		23	27	26			
	28		23	24	27			
	29		26	27	30			
	30		6	7	15			
	31		6	15	14			
	32		14	15	21			
	33		14	21	20			
	34		20	21	25			
	35		20	25	24			
	36		24	28	27			
	37		24	25	28			
	38		25	29	28			
	39		27	31	30			
	40		27	28	31			
	41		28	32	31			
	42		28	29	32			
	43		29	33	32			
	44		30	31	34			
	45		31	35	34			
	46		31	32	35			
	47		32	36	35			
	48		32	33	36			
	49		34	35	37			
	50		35	36	37			
	51		35	36	38			
	52	4	2	8		9.8	2	
	53	4	8	9			40.	
	54		9	3				
	55		9	10				
	56		10	11				
	57		11	12				
	58		12	4				
	59		11	16				
	60		16	17				
	61		17	12				
	62		17	18				
	63		18	19				

```
      64          19    13
      65          13    12
      66          13     5
      67          19    22
      68          22    23
      69          19    20
      70          13    14
      71          23    24
      72          23    26
      73          26    27
      74           6    14
      75          14    2
      76          20    24
      77          24    27
      78          27    30
      79          30    31
      80          27    28
      81          24    25
      82          20    21
      83          14    15
      84           7    15
      85          15    21
      86          21    25
      87          25    29
      88          29    28
      89          28    31
      90          31    32
      91          32    33
      92          33    29
      93          33    36
      94          36    35
      95          35    32
      96          31    34
      97          34    35
      98          35    37
      99          37    38
1    100          38    36
     1 000      2 000     3 000      4 000      5 000      6 000      7 000
     1     4    18          .10        .10        .10
     4     6    14    12    .10        .10        .10        .10
    12    14    20    15    .10        .10        .10        .10
    18    20    30          .10        .10        .10        .10
    33    30    37    38    -1.        -1.        -1.        -1.
1    6     7    33    [illegible]    .10        .10        .10        .10
 $TETA  ITHETA=0$
1VMASS          1    51    4.[illegible]E-5
1PLOAD          1    51    0.5
. 0           .25          .45        .61        .74        .85        .95
     7     6     4     4     4     4     3
     2     4     6     7
     1     2     3     4     5     6     7
    10    11    12    13    14    15
    18    19    20    21
    22    23    24    25
    26    27    28    29
    30    31    32    33
    34    35    36
$CONSTR STRESS=.T., GAGE=.T., FLUTTER=.T.$
$OPTIMUM $
      THREE FLUTTER M=.75
$NAM1 MACH=.75, NK=12, KMAX=2.5, KMIN=0., KMED=1.,
```

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Example 1 Output

```
EXAMPLE   1 FULL DEPTH SANDWICH WING ANALYSIS RUN

INPUT OPTIONS

    IPRINT = 2      1 - NORMAL PRINTOUT, 2 - EXTENDED PRINTOUT
    IZCOR = 0       0 - BICONVEX SYMMETRIC, -1 - INPUT Z COORDINATES
    IOPT = 1        1 - A SINGLE ANALYSIS, 2 - OPTIMIZATION
    IPUNCH = 0      1 - PUNCH A NASTRAN DECK, 0 - NO PUNCH

$DIMNSHN

NEL      =  100,
NNOD     =  38,
NTSEG    =  6,
NSN      =  20,
NEIG     =  5,
NVEC     =  9,
NMAT     =  2,
NDV      =  0,
NOC      =  7,
NF       =  3,
NYS      =  7,
NYC      =  4,
NS       =  4,
NXP      =  10,
NFREE    =  0,
NL       =  0,
NT       =  0,
$END
$ADRESS
NODES    =  1,
COON     =  401,
IA       =  515,
ITYPE    =  1256,
MAT      =  1356,
ELTHK    =  1456,
LI       =  1556,
NRR      =  1594,
A        =  1708,
RHOA     =  1711,
GAMA     =  1714,
V        =  1720,
```

```
VI      =  1726,
DV      =  1732,
VF      =  1738,
VCR     =  1744,
ACTIV   =  1747,
KF      =  1753,
YY      =  1756,
NY      =  1763,
IY      =  1770,
KC      =  1840,
XI      =  1847,
THETA   =  1917,
Q       =  2017,
SIGMA   =  2035,
THTSEG  =  2041,
IGAIN   =  2047,
SG      =  2050,
NK      =  2053,
MACH    =  2056,
KM      =  2059,
NTAPE   =  2068,
REF     =  2071,
TUL     =  2074,
XPL     =  2079,
YPL     =  2083,
SPL     =  2087,
RHOE    =  2091,
NNN     =  2093,
NSE     =  2213,
NNS     =  2313,
MASS    =  2319,
VECLOD  =  2357,
VECMAS  =  2471,
VECNSM  =  2509,
VSRM    =  2547,
CSAV    =  2585,
DC      =  2585,
DIRCOS  =  2585,
NODSEG  =  2585,
```

```
TSEG    =  2609,

NDSIGN  =  2633,

C       =  2657,

NELOS   =  2658,

AD      =  2758,

VFREE   =  2758,

X       =  2758,

Z       =  2768,

UTHICK  =  2778,

INIT    =  3258,

IFIN    =  3259,

ISTORE  =  3260,

NDC     =  3261,

INC     =  3268,

DHDX    =  3289,

TNOD    =  3359,

FK      =  3587,

$END
WING DESCRIPTION

     ASPECT RATIO............AR =  2.55380000E+00
     SURFACE AREA..........AREA =  1.13161600E+06
     L.E. SWEEP ANGLE...ANGLE1 =  5.05000000E+01 DEGREES
     SEMISPAN................SS =  8.49988374E+02
     SEMI-ROOT CHORD.......BREF =  5.90618621E+02
     TAPER RATIO..........TAPER =  1.27065000E-01
     DEPTH RATIO.............DR =  3.00000000E-02
$UNIT

G       =  0.3864E+03,

LUNIT   =  0.254E-01,

MUNIT   =  0.1751268348E+03,

MNORM   =  0.1E+01,

$END


FLUTTER CONDITION  1


SUBSONIC KERNEL FUNCTION AERODYNAMICS

     MACH NUMBER....................MACH =  6.00000000E-01
     AERO DATA TAPE NUMBER.......NTAPE =  17
     NUMBER OF K VALUES.............NK =  10
     MAXIMUM K....................KMAX =  2.00000000E+00
     MEDIAN K.....................KMED =  1.00000000E+00
     MINIMUM K....................KMIN =  0.
     GAIN FACTOR.................IGAIN =  10
     STRUCTURAL DAMPING.............SG =  2.00000000E-02
     REFERENCE FREQUENCY...........REF =  1.00000000E+02

     OMEGA INITIAL..............OMINIT =             IIIII RADIANS/SEC.
     OMEGA INCREMENT.............DELOM =             IIIII RADIANS/SEC.
     H INITIAL...................HINIT = -1.52400000E+03 METERS
     H INCREMENT..................DELH =             IIIII METERS
     H LOWER BOUND................HFIN =             IIIII METERS
```

FLUTTER CONDITION 2

SUBSONIC KERNEL FUNCTION AERODYNAMICS

```
MACH NUMBER..................MACH =  7.50000000E-01
AERO DATA TAPE NUMBER......NTAPE =  18
NUMBER OF K VALUES.............NK =  12
MAXIMUM K....................KMAX =  2.50000000E+00
MEDIAN K.....................KMED =  1.00000000E+00
MINIMUM K....................KMIN =  0.
GAIN FACTOR.................IGAIN =  10
STRUCTURAL DAMPING.............SG =  2.00000000E-02
REFERENCE FREQUENCY...........REF =  1.00000000E+02

OMEGA INITIAL..............OMINIT =             IIIII RADIANS/SEC.
OMEGA INCREMENT.............DELOM =             IIIII RADIANS/SEC.
H INITIAL...................HINIT =  3.04800000E+03 METERS
H INCREMENT..................DELH =             IIIII METERS
H LOWER BOUND................HFIN =             IIIII METERS
```

FLUTTER CONDITION 3

SUPERSONIC PISTON THEORY AERODYNAMICS

```
SPEED OF SOUND..................A =  1.22040000E+04
AIR MASS DENSITY.............RHOA =  5.14000000E-08
CP/CV........................GAMA =  1.40000000E+00

OMEGA INITIAL..............OMINIT =  0.             RADIANS/SEC.
OMEGA INCREMENT.............DELOM =  1.00000000E+00 RADIANS/SEC.
OMEGA FINAL.................OMFIN =  2.00000000E+01 RADIANS/SEC.
V INITIAL...................VINIT =  1.50000000E+04
V INCREMENT..................DELV =  1.00000000E+03
V FINAL......................VFIN =  4.00000000E+04
```

MATERIAL PROPERTIES

	Q11	Q21	Q22	Q31	Q32	Q33
1	1.8022E+07	5.4066E+06	1.8022E+07	0.	0.	1.2615E+07
2	1.8022E+07	5.4066E+06	1.8022E+07	0.	0.	1.2615E+07

SIGMA1	SIGMA2	SIGMA12	RHO
1.2500E+05	1.2500E+05	7.2170E+04	4.1400E-04
1.2500E+05	1.2500E+05	7.2170E+04	0.

SEGMENT DATA

SEGMENT 1 IS DEFINED BY NODES 1 4 18 -0 MATERIAL ORIENTATION I DEGREES

NODE	THICKNESS
1	1.00000000E-01
2	1.00000000E-01
3	1.00000000E-01
4	1.00000000E-01
8	1.00000000E-01
9	1.00000000E-01
10	1.00000000E-01
11	1.00000000E-01
12	1.00000000E-01
16	1.00000000E-01
17	1.00000000E-01
18	1.00000000E-01

```
SEGMENT  2 IS DEFINED BY NODES    4  6 14 12     MATERIAL ORIENTATION      1 DEGREES

   NODE      THICKNESS

    4      1.00000000E-01
    5      1.00000000E-01
    6      1.00000000E-01
   12      1.00000000E-01
   13      1.00000000E-01
   14      1.00000000E-01

SEGMENT  3 IS DEFINED BY NODES   12 14 20 18     MATERIAL ORIENTATION      1 DEGREES

   NODE      THICKNESS

   12      1.00000000E-01
   13      1.00000000E-01
   14      1.00000000E-01
   17      1.00000000E-01
   18      1.00000000E-01
   19      1.00000000E-01
   20      1.00000000E-01

SEGMENT  4 IS DEFINED BY NODES   18 20 30 -0     MATERIAL ORIENTATION      1 DEGREES

   NODE      THICKNESS

   18      1.00000000E-01
   19      1.00000000E-01
   20      1.00000000E-01
   22      1.00000000E-01
   23      1.00000000E-01
   24      1.00000000E-01
   26      1.00000000E-01
   27      1.00000000E-01
   30      1.00000000E-01

SEGMENT  5 IS DEFINED BY NODES   33 30 37 38     MATERIAL ORIENTATION      1 DEGREES

   NODE      THICKNESS

   30     -1.00000000E+00
   31     -1.00000000E+00
   32     -1.00000000E+00
   33     -1.00000000E+00
   34     -1.00000000E+00
   35     -1.00000000E+00
   36     -1.00000000E+00
   37     -1.00000000E+00
   38     -1.00000000E+00

SEGMENT  6 IS DEFINED BY NODES    6  7 33 30     MATERIAL ORIENTATION      1 DEGREES

   NODE      THICKNESS

    6      1.00000000E-01
    7      1.00000000E-01
   14      1.00000000E-01
   15      1.00000000E-01
   20      1.00000000E-01
   21      1.00000000E-01
   24      1.00000000E-01
   25      1.00000000E-01
   27      1.00000000E-01
   28      1.00000000E-01
   29      1.00000000E-01
   30      1.00000000E-01
   31      1.00000000E-01
   32      1.00000000E-01
   33      1.00000000E-01
```

NODAL DATA

NODE	NRR	X	Y	Z	MASS
1	000	3.0933960E+01	0.	1.8074321E+00	3.9903198E-01
2	000	1.5466980E+02	0.	8.0650512E+00	2.3332753E+00
3	000	2.8871696E+02	0.	1.3088941E+01	3.3043610E+00
4	000	4.9494336E+02	0.	1.7253601E+01	1.6281453E+01
5	000	6.5992448E+02	0.	1.7474579E+01	1.6696017E+01
6	000	9.0739616E+02	0.	1.2621462E+01	1.2748439E+01
7	000	1.1548678E+03	0.	1.5468446E+00	2.0261142E+00
8	111	1.5466980E+02	1.0200000E+02	1.8017417E+00	1.4708037E+00
9	111	2.8871696E+02	1.0200000E+02	8.3545352E+00	7.7493428E+00
10	111	2.8871696E+02	2.1250000E+02	1.7938571E+00	1.2044317E+00
11	111	3.9183016E+02	2.1250000E+02	6.8753323E+00	5.8514008E+00
12	111	4.9494336E+02	2.1250000E+02	1.0575160E+01	7.7962195E+00
13	111	6.5992448E+02	2.1250000E+02	1.3621056E+01	2.5316531E+01
14	111	9.0739616E+02	2.1250000E+02	1.1557989E+01	2.4229432E+01
15	111	1.1548678E+03	2.1250000E+02	1.5366315E+00	6.5517108E+00
16	111	3.9183016E+02	2.9750000E+02	1.7860393E+00	1.3058982E+00
17	111	4.9494336E+02	2.9750000E+02	6.7285769E+00	4.6073387E+00
18	111	4.9494336E+02	3.8250000E+02	1.7759744E+00	1.5595538E+00
19	111	6.5992448E+02	3.8250000E+02	8.5439254E+00	1.0647424E+01
20	111	9.0739616E+02	3.8250000E+02	1.0156974E+01	1.7546598E+01
21	111	1.1548678E+03	3.8250000E+02	1.5233688E+00	4.8752140E+00
22	111	6.5992448E+02	5.1850000E+02	1.7520545E+00	1.9164768E+00
23	111	7.9397164E+02	5.1850000E+02	6.9415372E+00	6.0720988E+00
24	111	9.0739616E+02	5.1850000E+02	8.2828984E+00	5.7349033E+00
25	111	1.1548678E+03	5.1850000E+02	1.5057877E+00	4.2458238E+00
26	111	7.9397164E+02	6.2900000E+02	1.7187243E+00	1.1696217E+00
27	111	9.0739616E+02	6.2900000E+02	5.6714982E+00	2.7572432E+00
28	111	9.8988672E+02	6.2900000E+02	6.2274639E+00	3.7510129E+00
29	111	1.1548678E+03	6.2900000E+02	1.4814275E+00	1.1719953E+00
30	111	9.0739616E+02	7.2250000E+02	1.6676223E+00	6.2511007E-01
31	111	9.8988672E+02	7.2250000E+02	4.2725739E+00	1.3131149E+00
32	111	1.0620660E+03	7.2250000E+02	4.3539431E+00	1.5595128E+00
33	111	1.1548678E+03	7.2250000E+02	1.4442105E+00	3.0726553E-01
34	111	9.8988672E+02	7.9050000E+02	1.5976985E+00	2.7430620E-01
35	111	1.0620660E+03	7.9050000E+02	3.3165591E+00	7.0258575E-01
36	111	1.1548678E+03	7.9050000E+02	1.3933901E+00	3.2031959E-01
37	111	1.0620660E+03	8.5000000E+02	1.4734612E+00	1.5204059E-01
38	111	1.1548678E+03	8.5000000E+02	1.3032014E+00	1.6417938E-01

LOAD DATA

NODE	XLOAD	YLOAD	ZLOAD
1	0.	0.	1.0517546E+03
2	0.	0.	3.3305564E+03
3	0.	0.	2.8923253E+03
4	0.	0.	1.2197432E+04
5	0.	0.	1.1686163E+04
6	0.	0.	1.3146933E+04
7	0.	0.	4.3823110E+03
8	0.	0.	3.4255064E+03
9	0.	0.	8.9910414E+03
10	0.	0.	2.9142368E+03
11	0.	0.	7.0116976E+03
12	0.	0.	7.3768902E+03
13	0.	0.	2.0742939E+04
14	0.	0.	2.3664479E+04
15	0.	0.	1.2270471E+04
16	0.	0.	2.9215407E+03
17	0.	0.	6.1352354E+03
18	0.	0.	3.7687875E+03
19	0.	0.	1.3205364E+04
20	0.	0.	2.0217061E+04
21	0.	0.	9.8163766E+03
22	0.	0.	4.6233381E+03
23	0.	0.	8.9326106E+03
24	0.	0.	8.1730100E+03
25	0.	0.	9.4073609E+03
26	0.	0.	3.1625678E+03
27	0.	0.	5.0177461E+03
28	0.	0.	7.0482169E+03
29	0.	0.	3.5277604E+03
30	0.	0.	1.9939515E+03
31	0.	0.	3.1333524E+03
32	0.	0.	4.0317261E+03
33	0.	0.	1.2489586E+03
34	0.	0.	1.2343509E+03
35	0.	0.	2.6220827E+03
36	0.	0.	1.5118973E+03
37	0.	0.	8.1803139E+02
38	0.	0.	9.2028531E+02

TOTAL MASS IS 2.067382E+02

ELEMENT DATA

ELEMENT	NODES				SEGMENT	TYPE	THICKNESS	MATERIAL	THETA
1	1	2	8	-0	1	2	1.0000000E-01	1	1.6300000E+01
2	2	3	9	-0	1	2	1.0000000E-01	1	-0.
3	2	9	8	-0	1	2	1.0000000E-01	1	-0.
4	8	9	10	-0	1	2	1.0000000E-01	1	-0.
5	3	4	9	-0	1	2	1.0000000E-01	1	-0.
6	9	4	11	-0	1	2	1.0000000E-01	1	-0.
7	9	11	10	-0	1	2	1.0000000E-01	1	-0.
8	4	12	11	-0	1	2	1.0000000E-01	1	-0.
9	10	11	16	-0	1	2	1.0000000E-01	1	-0.
10	11	12	16	-0	1	2	1.0000000E-01	1	-0.
11	12	17	16	-0	1	2	1.0000000E-01	1	-0.
12	16	17	18	-0	1	2	1.0000000E-01	1	-0.
13	4	5	13	-0	2	2	1.0000000E-01	1	-0.
14	4	13	12	-0	2	2	1.0000000E-01	1	-0.
15	12	13	17	-0	3	2	1.0000000E-01	1	-0.
16	13	19	17	-0	3	2	1.0000000E-01	1	-0.
17	17	19	18	-0	3	2	1.0000000E-01	1	-0.
18	18	19	22	-0	4	2	1.0000000E-01	1	-0.
19	5	6	14	-0	2	2	1.0000000E-01	1	-0.
20	5	14	13	-0	2	2	1.0000000E-01	1	-0.
21	13	14	20	-0	3	2	1.0000000E-01	1	-0.
22	13	20	19	-0	3	2	1.0000000E-01	1	-0.
23	19	20	23	-0	4	2	1.0000000E-01	1	-0.
24	20	24	23	-0	4	2	1.0000000E-01	1	-0.
25	19	23	22	-0	4	2	1.0000000E-01	1	-0.
26	22	23	26	-0	4	2	1.0000000E-01	1	-0.
27	23	27	26	-0	4	2	1.0000000E-01	1	-0.

28	23	24	27	-0	4	2	1.0000000E-01	1	-0.
29	26	27	30	-0	4	2	1.0000000E-01	1	-0.
30	6	7	15	-0	6	2	1.0000000E-01	1	-0.
31	6	15	14	-0	6	2	1.0000000E-01	1	-0.
32	14	15	21	-0	6	2	1.0000000E-01	1	-0.
33	14	21	20	-0	6	2	1.0000000E-01	1	-0.
34	20	21	25	-0	6	2	1.0000000E-01	1	-0.
35	20	25	24	-0	6	2	1.0000000E-01	1	-0.
36	24	28	27	-0	6	2	1.0000000E-01	1	-0.
37	24	25	28	-0	6	2	1.0000000E-01	1	-0.
38	25	29	28	-0	6	2	1.0000000E-01	1	-0.
39	27	31	30	-0	6	2	1.0000000E-01	1	-0.
40	27	28	31	-0	6	2	1.0000000E-01	1	-0.
41	28	32	31	-0	6	2	1.0000000E-01	1	-0.
42	28	29	32	-0	6	2	1.0000000E-01	1	-0.
43	29	33	32	-0	6	2	1.0000000E-01	1	-0.
44	30	31	34	-0	5	2	2.0000000E-02	1	-0.
45	31	35	34	-0	5	2	2.0000000E-02	1	-0.
46	31	32	35	-0	5	2	2.0000000E-02	1	-0.
47	32	36	35	-0	5	2	2.0000000E-02	1	-0.
48	32	33	36	-0	5	2	2.0000000E-02	1	-0.
49	34	35	37	-0	5	2	2.0000000E-02	1	-0.
50	35	38	37	-0	5	2	2.0000000E-02	1	-0.
51	35	36	38	-0	5	2	2.0000000E-02	1	-0.
52	2	8	-0	-0	0	4	9.8000000E+00	2	-0.
53	8	9	-0	-0	0	4	9.8000000E+00	2	4.0000000E+01
54	9	3	-0	-0	0	4	9.8000000E+00	2	-0.
55	9	10	-0	-0	0	4	9.8000000E+00	2	-0.
56	10	11	-0	-0	0	4	9.8000000E+00	2	-0.
57	11	12	-0	-0	0	4	9.8000000E+00	2	-0.
58	12	4	-0	-0	0	4	9.8000000E+00	2	-0.
59	11	16	-0	-0	0	4	9.8000000E+00	2	-0.
60	16	17	-0	-0	0	4	9.8000000E+00	2	-0.
61	17	12	-0	-0	0	4	9.8000000E+00	2	-0.
62	17	18	-0	-0	0	4	9.8000000E+00	2	-0.
63	18	19	-0	-0	0	4	9.8000000E+00	2	-0.
64	19	13	-0	-0	0	4	9.8000000E+00	2	-0.
65	13	12	-0	-0	0	4	9.8000000E+00	2	-0.
66	13	5	-0	-0	0	4	9.8000000E+00	2	-0.
67	19	22	-0	-0	0	4	9.8000000E+00	2	-0.
68	22	23	-0	-0	0	4	9.8000000E+00	2	-0.
69	19	20	-0	-0	0	4	9.8000000E+00	2	-0.
70	13	14	-0	-0	0	4	9.8000000E+00	2	-0.
71	23	24	-0	-0	0	4	9.8000000E+00	2	-0.
72	23	26	-0	-0	0	4	9.8000000E+00	2	-0.
73	26	27	-0	-0	0	4	9.8000000E+00	2	-0.
74	6	14	-0	-0	0	4	9.8000000E+00	2	-0.
75	14	20	-0	-0	0	4	9.8000000E+00	2	-0.
76	20	24	-0	-0	0	4	9.8000000E+00	2	-0.
77	24	27	-0	-0	0	4	9.8000000E+00	2	-0.
78	27	30	-0	-0	0	4	9.8000000E+00	2	-0.
79	30	31	-0	-0	0	4	9.8000000E+00	2	-0.
80	27	28	-0	-0	0	4	9.8000000E+00	2	-0.
81	24	25	-0	-0	0	4	9.8000000E+00	2	-0.
82	20	21	-0	-0	0	4	9.8000000E+00	2	-0.
83	14	15	-0	-0	0	4	9.8000000E+00	2	-0.
84	7	15	-0	-0	0	4	9.8000000E+00	2	-0.
85	15	21	-0	-0	0	4	9.8000000E+00	2	-0.
86	21	25	-0	-0	0	4	9.8000000E+00	2	-0.
87	25	29	-0	-0	0	4	9.8000000E+00	2	-0.
88	29	28	-0	-0	0	4	9.8000000E+00	2	-0.
89	28	31	-0	-0	0	4	9.8000000E+00	2	-0.
90	31	32	-0	-0	0	4	9.8000000E+00	2	-0.
91	32	33	-0	-0	0	4	9.8000000E+00	2	-0.
92	33	29	-0	-0	0	4	9.8000000E+00	2	-0.
93	33	36	-0	-0	0	4	9.8000000E+00	2	-0.
94	36	35	-0	-0	0	4	9.8000000E+00	2	-0.
95	35	32	-0	-0	0	4	9.8000000E+00	2	-0.
96	31	34	-0	-0	0	4	9.8000000E+00	2	-0.
97	34	35	-0	-0	0	4	9.8000000E+00	2	-0.
9	35	37	-0	-0	0	4	9.8000000E+00	2	-0.
99	37	38	-0	-0	0	4	9.8000000E+00	2	-0.
100	38	36	-0	-0	0	4	9.8000000E+00	2	-0.

AERO MESH DATA

STATION	NODES						
0.0000	1	2	3	4	5	6	7
.2500	10	11	12	13	14	15	
.4500	18	19	20	21			
.6100	22	23	24	25			
.7400	26	27	28	29			
.8500	30	31	32	33			
.9300	34	35	36				

COLLOCATION STATIONS 2 4 6 7

```
DESIGN CONSTRAINTS CONSIDERED
    FLUTTER - T
     STRESS - T
    MINGAGE - T

TOTAL NUMBER OF D.O.F. = 93
THIS PROGRAM REQUIRES 011360(OCTAL) OF BLANK COMMON
$OPTIMUM  $
$NAM1
MACH    =  0.75E+00,
NK      =  12,
KMAX    =  0.25E+01,
KMED    =  0.1E+01,
KMIN    =  0.0,
NM      =  28794890117500613 2,
SYM     =  0,
ZETA    =  0.1E+00,
NG      =  5,
XG      =  0.148874338981 63E+00,  0.433395394129 25E+00,  0.679409568299 03E+00,
           0.865063366688 99E+00,  0.973906528517 17E+00, I, I, I, I, I, I, I, I,
         I, I, I, I, I, I, I, I, I, I, I,
WG      =  0.295524224714 75E+00,  0.269266719311E+00,  0.219086362515 98E+00,
           0.149451349150 58E+00,  0.666713443086 88E-01, I, I, I, I, I, I, I, I,
         I, I, I, I, I, I, I, I, I, I, I,
$END
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MISCELLANEOUS GEOMETRIC PARAMETERS

ROOT SEMICHORD, BREF = 590.618620635

SEMISPAN/BREF = 1.43914929850

REFERENCE VOLUME = 354962180.333

PANEL AREA = 565808.000000

PANEL ASPECT RATIO = 1.27690000000

MEAN AERODYNAMIC CHORD = 798.772525106

MEAN CHORD = 665.665575666

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$ADRESS
NODES  =  1,
COON   =  401,
IA     =  515,
ITYPE  =  1256,
MAT    =  1356,
ELTHK  =  1456
LI     =  1556
NRR    =  1594
RA     =  1708
RHOA   =  1711
GAMA   =  1714
V      =  1720
VI     =  1726
DV     =  1732
VF     =  1738,
VCR    =  1744,
ACTIV  =  1747,
KF     =  1753,
YY     =  1756,
NY     =  1763,
IY     =  1770,
KC     =  1840,
XI     =  1847,
THETA  =  1917,
Q      =  2017,
SIGMA  =  2035,
THTSEG =  2041,
IGAIN  =  2047,
SG     =  2050,
NK     =  2053,
MACH   =  2056,
KM     =  2059,
NTAPE  =  2068,
REF    =  2071,
TUL    =  2074,
XPL    =  2079,
YPL    =  2083,
BPL    =  2087,
RHOE   =  2091,
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NNN     =  2093,
NSE     =  2213,
NNS     =  2313,
MASS    =  2319,
VECLOD  =  2357,
VECMAS  =  2471,
VECNSM  =  2509,
VSRM    =  2547,
CSAV    =  2585,
DC      =  2585,
DIRCOS  =  2585,
NODSEG  =  2585,
TSEG    =  2609,
NDSIGN  =  2633,
C       =  2657,
NELDS   =  2658,
AD      =  2758,
VFREE   =  2758,
UTHICK  =  2778,
INIT    =  3258,
IFIN    =  3259,
ISTORE  =  3260,
NDC     =  3261,
INC     =  3268,
DHDX    =  3289,
TNOD    =  3359,
FK      =  3587,
VK      =  4848,
VDK     =  4860,
D       =  4872,
H       =  4872,
HH      =  4872,
EQSTR   =  4872,
VV      =  4972,
DE      =  5314,
STR     =  5323,
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W      = 5623,
DISP   = 5737,
UE     = 5323,
BE     = 6349,
BB     = 6430,
T      = 6475,
ISET   = 6513,
AAC    = 5323,
VMAT   = 5373,
OMMAT  = 5398,
VOMAT  = 5423,
V2MAT  = 5448,
GFR    = 5373,
GFI    = 5673,
FREQ   = 5973,
GM     = 5978,
DZ     = 5373,
ZH     = 5389,
FQ     = 5405,
F      = 5421,
X      = 5470,
HF     = 5480,
RGF    = 5490,
TT     = 5510,
EB     = 5679,
FB     = 5700,
MATAER = 5473,
BDZ    = 6003,
BZH    = 6083,
BFQ    = 6163,
YAR    = 6243,
TR     = 6259,
TI     = 6284,
BX     = 6309,
BY     = 6389,
GFRD   = 6003,
GFID   = 6303,
AMAT   = 6648,
AR     = 6984,
AI     = 6904,
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BMAT    =  7064,
VO      =  7320,
VPLUS   =  7326,
G11     =  7332,
GG1     =  7337,
G1      =  7342,
VA      =  7392,
V1      =  7452,
VP      =  7458,
VPP     =  7464,
G1O     =  7470,
G1P     =  7475,
G1PP    =  7480,
EQSS    =  7485,
VOR     =  7585,
VS      =  7585,
GP1     =  7588,
MARK    =  7593,
$END

THIS PROGRAM REQUIRES 016651(OCTAL) OF BLANK COMMON
```

DISPLACEMENT FIELD

NODE	U	V	W
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	0.	0.
5	0.	0.	0.
6	0.	0.	0.
7	0.	0.	0.
8	9.02201090E-03	-4.99859752E-04	5.21390586E-03
9	-2.50228409E-02	-4.50695418E-02	2.15568331E-01
10	2.99366556E-03	-1.48312689E-02	8.67557447E-01
11	-5.81191646E-02	-1.32989099E-01	1.52225528E+00
12	-9.73373774E-02	-3.18970157E-01	2.43937879E+00
13	-1.91367527E-01	-6.44104210E-01	4.40678178E+00
14	-2.10720474E-01	-9.46939869E-01	8.35014730E+00
15	1.20113494E-02	-1.75732722E-01	1.21108374E+01
16	-2.75570751E-02	-4.70864836E-02	3.28952147E+00
17	-1.42001139E-01	-2.71841164E-01	5.34255438E+00
18	-2.66900860E-02	-9.14851105E-02	8.97492875E+00
19	-3.40490835E-01	-7.16075752E-01	1.48453968E+01
20	-4.69734572E-01	-1.25173292E+00	2.55718694E+01
21	-2.74782101E-02	-2.56091349E-01	3.61080024E+01
22	-1.09872450E-01	-2.13532687E-01	2.71277410E+01
23	-4.74050471E-01	-9.05374169E-01	3.61336169E+01
24	-5.95274545E-01	-1.25926364E+00	4.40986065E+01
25	-8.19802209E-02	-3.03343653E-01	6.12251751E+01
26	-1.50807980E-01	-2.72924754E-01	5.11701394E+01
27	-5.37240667E-01	-9.67081597E-01	6.17318622E+01
28	-5.73929223E-01	-1.10138894E+00	6.94380785E+01
29	-1.19679179E-01	-3.19885148E-01	8.42824604E+01
30	-1.64570196E-01	-3.01681042E-01	7.78964843E+01
31	-4.60622829E-01	-8.23182559E-01	8.65785802E+01
32	-4.62305844E-01	-8.57986513E-01	9.43028238E+01
33	-1.55234703E-01	-3.02964351E-01	1.04187695E+02
34	-1.81083652E-01	-3.36196654E-01	1.00008849E+02
35	-4.13414393E-01	-7.70502759E-01	1.08740603E+02
36	-1.72302803E-01	-3.68587523E-01	1.20281468E+02
37	-2.13013924E-01	-3.63467834E-01	1.22826746E+02
38	-1.84049332E-01	-3.48211905E-01	1.36097761E+02

STRESS FIELD

ELEMENT	THICKNESS	SIGMA X	SIGMA Y	SIGMA XY	STRESS RATIO
1	1.00000000E-01	-2.58938878E+02	4.40003303E+02	-4.55958564E+02	.008
2	1.00000000E-01	2.91460133E+03	9.71533775E+03	1.04590634E+03	.071
3	1.00000000E-01	4.51253609E+03	-1.58076018E+02	-4.58620767E+02	.037
4	1.00000000E-01	3.59831051E+03	2.32699741E+03	-7.25033867E+02	.027
5	1.00000000E-01	2.91406262E+03	9.71354207E+03	1.27653257E+03	.071
6	1.00000000E-01	5.40794873E+03	1.66291337E+04	-4.19263199E+03	.131
7	1.00000000E-01	1.02542758E+04	-1.85860542E+03	-1.70558117E+03	.093
8	1.00000000E-01	3.38638431E+04	1.12009008E+04	-1.34420657E+04	.303
9	1.00000000E-01	6.29417700E+03	5.72303074E+03	9.02706108E+02	.050
10	1.00000000E-01	2.37712792E+03	4.58436836E+03	7.74498040E+03	.112
11	1.00000000E-01	1.86885862E+04	8.22102853E+03	-1.24196778E+04	.216
12	1.00000000E-01	4.77870398E+03	7.44694132E+03	-4.04475465E+02	.053
13	1.00000000E-01	1.84150932E+04	6.13836441E+04	5.50412853E+03	.443
14	1.00000000E-01	4.40999339E+04	7.70395062E+03	5.17003909E+03	.334
15	1.00000000E-01	1.16605021E+04	1.97533218E+04	1.51568459E+04	.251
16	1.00000000E-01	4.10102399E+04	1.34166146E+04	-1.58206880E+04	.363
17	1.00000000E-01	2.39100244E+04	-4.81594810E+03	9.67418354E+03	.252
18	1.00000000E-01	1.23558163E+04	1.70450084E+04	1.03302438E+03	.123
19	1.00000000E-01	2.51544575E+04	8.38481918E+04	1.11129793E+04	.616
20	1.00000000E-01	5.54414006E+04	2.92917728E+04	2.23839328E+04	.494
21	1.00000000E-01	1.80081116E+04	4.84908360E+04	2.34821780E+04	.470
22	1.00000000E-01	4.78466055E+04	1.06237965E+04	2.07644460E+04	.452
23	1.00000000E-01	1.15134326E+04	2.52732074E+04	1.68959756E+04	.292
24	1.00000000E-01	3.61132368E+04	1.47507512E+04	-2.14445983E+04	.389
25	1.00000000E-01	3.19553885E+04	-1.00490253E+04	4.08406307E+03	.309
26	1.00000000E-01	5.90608034E+03	1.33647242E+04	9.05011603E+02	.094
27	1.00000000E-01	2.81109535E+04	-7.65760778E+03	3.89707173E+03	.266
28	1.00000000E-01	1.03877623E+04	2.16002211E+04	1.49269673E+04	.255
29	1.00000000E-01	4.46207128E+03	6.03387144E+03	6.12584891E+02	.044
30	1.00000000E-01	4.48591166E+03	1.49530389E+04	1.57147714E+04	.242
31	1.00000000E-01	4.35888705E+04	5.87619777E+04	3.03391215E+04	.596
32	1.00000000E-01	-2.50637860E+03	7.18079144E+03	1.78570056E+04	.257
33	1.00000000E-01	2.87554673E+04	2.57346065E+04	2.03771158E+04	.357
34	1.00000000E-01	-3.42439654E+03	5.06209130E+03	1.78151407E+04	.254
35	1.00000000E-01	2.26752600E+04	1.83893413E+04	1.71342243E+04	.290
36	1.00000000E-01	2.69002263E+04	-4.83268892E+03	3.91794293E+03	.243
37	1.00000000E-01	2.87483068E+03	1.93561278E+04	1.40606685E+04	.243
38	1.00000000E-01	2.63552557E+03	-1.91303771E+03	-1.02562757E+04	.146
39	1.00000000E-01	1.51469476E+04	-2.19030748E+03	-9.59526146E+02	.131
40	1.00000000E-01	1.30294805E+03	1.44485183E+04	7.15057834E+03	.149
41	1.00000000E-01	1.83626793E+04	-5.63499202E+02	3.74387011E+03	.158
42	1.00000000E-01	4.20854354E+02	1.04146023E+04	1.04124694E+04	.166
43	1.00000000E-01	-1.56781222E+03	3.46175035E+01	-7.04178522E+03	.098
44	2.00000000E-02	8.05640563E+03	1.23674903E+04	7.24105012E+02	.088
45	2.00000000E-02	2.33274627E+04	-1.15898886E+03	2.42386779E+03	.194
46	2.00000000E-02	8.80038796E+03	3.46549299E+04	7.29325859E+03	.269
47	2.00000000E-02	2.63632702E+04	1.88714634E+04	1.42352779E+04	.273
48	2.00000000E-02	6.72885746E+03	2.07455596E+04	1.11625158E+04	.213
49	2.00000000E-02	8.75070008E+03	1.07035892E+04	4.78419938E+03	.103
50	2.00000000E-02	1.13859333E+04	-1.02580872E+03	6.60627481E+03	.132
51	2.00000000E-02	-5.10034482E+01	9.75702549E+02	9.86103547E+03	.137
52	9.80000000E+00			1.28477220E+01	.000
53	9.80000000E+00			-1.81272728E+02	.003
54	9.80000000E+00			-1.14818926E+02	.002
55	9.80000000E+00			-6.27135156E+01	.001
56	9.80000000E+00			-2.28705408E+02	.003
57	9.80000000E+00			-1.36676647E+02	.002
58	9.80000000E+00			-1.80423820E+02	.002
59	9.80000000E+00			1.72758005E+01	.000
60	9.80000000E+00			-7.84721264E+01	.001
61	9.80000000E+00			-1.13271832E+02	.002
62	9.80000000E+00			2.96383590E+02	.004
63	9.80000000E+00			8.41024050E+01	.001
64	9.80000000E+00			-3.76413662E+02	.005
65	9.80000000E+00			5.52519268E+01	.001
66	9.80000000E+00			-1.95333602E+02	.003

67	9.80000000E+00	7.02486471E+02	.010
68	9.80000000E+00	4.32835721E+02	.006
69	9.80000000E+00	1.40701232E+02	.002
70	9.80000000E+00	-2.56738822E+02	.004
71	9.80000000E+00	-1.09855052E+02	.002
72	9.80000000E+00	4.83589727E+02	.007
73	9.80000000E+00	2.95165102E+02	.004
74	9.80000000E+00	9.07906148E+02	.013
75	9.80000000E+00	3.78535485E+02	.005
76	9.80000000E+00	4.16745893E+02	.006
77	9.80000000E+00	3.00391464E+02	.004
78	9.80000000E+00	1.49978070E+02	.002
79	9.80000000E+00	2.73711496E+01	.000
80	9.80000000E+00	2.46599706E+02	.003
81	9.80000000E+00	6.47576587E+02	.009
82	9.80000000E+00	2.84429294E+02	.004
83	9.80000000E+00	1.02297549E+03	.014
84	9.80000000E+00	2.64763944E+00	.000
85	9.80000000E+00	2.59777455E+02	.004
86	9.80000000E+00	1.06213112E+01	.000
87	9.80000000E+00	1.99867306E+02	.003
88	9.80000000E+00	-2.99372023E+01	.000
89	9.80000000E+00	2.66647845E+02	.004
90	9.80000000E+00	1.75794842E+02	.002
91	9.80000000E+00	1.79340630E+02	.002
92	9.80000000E+00	2.17037628E+01	.000
93	9.80000000E+00	7.36087863E+01	.001
94	9.80000000E+00	-4.23535523E+01	.001
95	9.80000000E+00	-1.22954355E+02	.002
96	9.80000000E+00	6.54967778E+01	.001
97	9.80000000E+00	-1.21180974E+01	.000
98	9.80000000E+00	8.26341197E+01	.001
99	9.80000000E+00	2.53623252E+01	.000
100	9.80000000E+00	-2.16393884E+01	.000

FLUTTER CONDITION NO. 1

01/16/74 DAMPING - VELOCITY/((REF LENGTH)*(REF FREQUENCY))

DENSITY PARAMETER = 3.548833996779E+02

2.000000	-.184138	-.165307	-.067282	-.124826	-.148431
	.031063	.096747	.160672	.171832	.079804
1.977778	-.186206	-.167329	-.065966	-.126666	-.148265
	.031428	.097892	.162280	.173784	.080552
1.955556	-.188328	-.169413	-.064586	-.128545	-.148052
	.031802	.099066	.163916	.175785	.081313
1.933333	-.190509	-.171565	-.063142	-.130464	-.147790
	.032186	.100269	.165581	.177837	.082087
1.911111	-.192750	-.173789	-.061634	-.132425	-.147479
	.032579	.101504	.167275	.179942	.082874
1.888889	-.195057	-.176088	-.060061	-.134429	-.147117
	.032982	.102771	.169000	.182102	.083676
1.866667	-.197434	-.178469	-.058422	-.136477	-.146702
	.033396	.104071	.170756	.184320	.084492
1.844444	-.199884	-.180937	-.056715	-.138572	-.146234
	.033821	.105406	.172544	.186598	.085323
1.822222	-.202414	-.183498	-.054940	-.140716	-.145711
	.034257	.106778	.174364	.188937	.086169
1.800000	-.205028	-.186158	-.053096	-.142910	-.145130
	.034705	.108187	.176217	.191340	.087030
1.777778	-.207732	-.188924	-.051180	-.145158	-.144491
	.035166	.109635	.178104	.193810	.087908
1.755556	-.210531	-.191803	-.049190	-.147462	-.143791
	.035639	.111125	.180026	.196350	.088802
1.733333	-.213432	-.194803	-.047122	-.149824	-.143027
	.036126	.112657	.181983	.198962	.089712
1.711111	-.216439	-.197931	-.044967	-.152247	-.142195
	.036626	.114233	.183977	.201649	.090640
1.688889	-.219558	-.201195	-.042720	-.154732	-.141291
	.037142	.115857	.186008	.204414	.091585
1.666667	-.222795	-.204604	-.040373	-.157283	-.140311
	.037672	.117529	.188078	.207261	.092548
1.644444	-.226157	-.208168	-.037917	-.159902	-.139250
	.038219	.119253	.190187	.210194	.093529
1.622222	-.229651	-.211897	-.035342	-.162593	-.138103
	.038782	.121030	.192337	.213215	.094529
1.600000	-.233286	-.215803	-.032639	-.165359	-.136864
	.039363	.122864	.194528	.216330	.095548
1.577778	-.237068	-.219898	-.029796	-.168203	-.135526
	.039963	.124757	.196761	.219542	.096586
1.555556	-.241008	-.224198	-.026801	-.171129	-.134083
	.040582	.126712	.199038	.222656	.097643
1.533333	-.245116	-.228716	-.023641	-.174142	-.132527
	.041222	.128732	.201360	.226277	.098721
1.511111	-.249403	-.233471	-.020300	-.177246	-.130846
	.041883	.130822	.203728	.229810	.099818
1.488889	-.253881	-.238479	-.016761	-.180445	-.129027
	.042568	.132983	.206144	.233462	.100936
1.466667	-.258566	-.243760	-.013007	-.183745	-.127057
	.043276	.135221	.208610	.237237	.102075
1.444444	-.263471	-.249337	-.009017	-.187152	-.124919
	.044009	.137540	.211128	.241143	.103235
1.422222	-.268613	-.255234	-.004769	-.190672	-.122596
	.044770	.139943	.213700	.245186	.104415
1.400000	-.274012	-.261476	-.000240	-.194311	-.120070
	.045558	.142435	.216328	.249375	.105617
1.377778	-.279687	-.268093	.004546	-.198076	-.117317
	.046377	.145022	.219017	.253717	.106840
1.355556	-.285662	-.275117	.009765	-.201976	-.114316
	.047228	.147707	.221768	.258221	.108084
1.333333	-.291962	-.282580	.015299	-.206019	-.111039
	.048112	.150499	.224586	.262896	.109349
1.311111	-.298614	-.290522	.021227	-.210214	-.107457
	.049033	.153400	.227476	.267752	.110636
1.288889	-.305651	-.298982	.027581	-.214570	-.103539
	.049992	.156420	.230442	.272802	.111944
1.266667	-.313107	-.308004	.034396	-.219101	-.099253
	.050992	.159562	.233490	.278056	.113274
1.244444	-.321023	-.317634	.041704	-.223817	-.094559
	.052035	.162836	.236628	.283529	.114625

1.222222	-.329442	-.327923	.049541	-.228733	-.089417
	.053126	.166248	.239861	.289234	.115999
1.200000	-.338416	-.338922	.057943	-.233864	-.083778
	.054266	.169805	.243201	.295187	.117395
1.177778	-.348001	-.350684	.066944	-.239227	-.077591
	.055461	.173516	.246657	.301406	.118815
1.155556	-.358263	-.363264	.076577	-.244840	-.070796
	.056713	.177388	.250242	.307909	.120258
1.133333	-.369277	-.376717	.086873	-.250723	-.063328
	.058028	.181431	.253968	.314717	.121725
1.111111	-.381126	-.391096	.097858	-.256901	-.055112
	.059411	.185653	.257851	.321854	.123219
1.088889	-.393909	-.406454	.109555	-.263399	-.046065
	.060867	.190064	.261910	.329345	.124740
1.066657	-.407737	-.422842	.121979	-.270244	-.036092
	.062402	.194673	.266161	.337217	.126290
1.044444	-.422737	-.440306	.135140	-.277469	-.025085
	.064022	.199492	.270627	.345504	.127874
1.022222	-.439055	-.458893	.149042	-.285108	-.012926
	.065736	.204531	.275329	.354239	.129495
1.000000	-.456358	-.478646	.163683	-.293204	.000518
	.067551	.209804	.280291	.363463	.131158
.977778	-.476337	-.499609	.179057	-.301803	.015390
	.069477	.215325	.285539	.373219	.132872
.955556	-.497708	-.521830	.195153	-.310958	.031852
	.071523	.221110	.291099	.383559	.134647
.933333	-.521214	-.545359	.211960	-.320732	.050073
	.073700	.227176	.296998	.394540	.136494
.911111	-.547129	-.570257	.229466	-.331199	.070237
	.076020	.233546	.303269	.406227	.138432
.888889	-.575753	-.596595	.247664	-.342443	.092537
	.078495	.240242	.309943	.418695	.140479
.866667	-.607415	-.624460	.266548	-.354566	.117172
	.081139	.247292	.317057	.432031	.142661
.844444	-.642470	-.653958	.286123	-.367693	.144346
	.083967	.254728	.324650	.446335	.145009
.822222	-.681300	-.685222	.306399	-.381971	.174267
	.086996	.262583	.332769	.461727	.147559
.800000	-.724311	-.718409	.327401	-.397584	.207146
	.090242	.270901	.341465	.478346	.150349
.777778	-.771940	-.753715	.349172	-.414757	.243205
	.093727	.279727	.350799	.496357	.153427
.755556	-.824670	-.791376	.371777	-.433772	.282690
	.097474	.289116	.360846	.515961	.156840
.733333	-.883044	-.831678	.395316	-.454988	.325883
	.101509	.299130	.371692	.537399	.160643
.711111	-.947707	-.874968	.419937	-.478871	.373136
	.105865	.309842	.383447	.560972	.164893
.688889	-1.019445	-.921673	.445855	-.506030	.424893
	.110582	.321336	.396245	.587050	.169653
.666667	-1.099245	-.972311	.473383	-.537287	.481733
	.115710	.333711	.410253	.616109	.174994
.644444	-1.188373	-1.027528	.502981	-.573766	.544415
	.121308	.347084	.425687	.648762	.180995
.622222	-1.288483	-1.088126	.535315	-.617058	.613936
	.127453	.361595	.442823	.685824	.187752
.600000	-1.401758	-1.155116	.571362	-.669472	.691606
	.134242	.377413	.462022	.728405	.195378
.577778	-1.531117	-1.229788	.612555	-.734499	.779161
	.141797	.394742	.483761	.778078	.204015
.555556	-1.680530	-1.313807	.661013	-.817651	.878920
	.150278	.413835	.508682	.837161	.213843
.533333	-1.855507	-1.409361	.719908	-.928137	.994036
	.159894	.435005	.537662	.909264	.225094
.511111	-2.063893	-1.519381	.794083	-1.082520	1.128889
	.170931	.458655	.571927	1.000414	.238076
.488889	-2.317221	-1.647869	.891142	-1.313781	1.289739
	.183783	.485301	.613246	1.121650	.253211
.466667	-2.633134	-1.800439	1.023517	-1.698145	1.485860
	.199021	.515629	.664274	1.296023	.271090
.444444	-3.040019	-1.985197	1.212750	-2.460423	1.731600
	.217502	.550573	.729222	1.582835	.292577
.422222	-3.586609	-2.214275	1.499461	-4.681738	2.050435
	.240591	.591444	.815313	2.211528	.318998
.400000	-4.364086	-2.506660	1.970504	-97.675856	2.483680
	.270633	.640165	.936422	10.216923	.352513
.377778	-5.565261	-2.893758	2.851823	I	3.111278
	.312099	.699693	1.124187	I	.396952

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.355556 -7.680828 -3.431438  4.976736         I  4.110607
           .374996   .774898  1.475824         I   .459945
.333333-12.436389 -4.229378 16.043709         I  5.969862
           .488815   .874522  2.622370         I   .559791
.311111-33.265515 -5.535931         I         I 10.699099
           .820387  1.016335         I         I   .758182
.288889         I -8.057414         I         I 48.687041
                I  1.244267         I         I  1.638986
.266667         I-14.911673         I         I         I
                I  1.715545         I         I         I
.244444         I*01.643973         I         I         I
                I  4.532581         I         I         I
.222222         I         I         I         I         I
                I         I         I         I         I
.200000         I         I         I         I         I
                I         I         I         I         I
.177778         I         I         I         I         I
                I         I         I         I         I
.155556         I         I         I         I         I
                I         I         I         I         I
.133333         I         I         I         I         I
                I         I         I         I         I
.111111         I         I         I         I         I
                I         I         I         I         I
.088889         I         I         I         I         I
                I         I         I         I         I
.066667         I         I         I         I         I
                I         I         I         I         I
.044444         I         I         I         I         I
                I         I         I         I         I
.022222         I         I         I         I         I
                I         I         I         I         I
0.000000        I         I         I         I         I
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VF=      1.33369353E-01     OMEGA=       1.28662558E+01

Z =    -879.9 ICODE =   0
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DENSITY PARAMETER = 3.341417690609E+02

2.000000	-.173105	-.155245	-.067812	-.115755	-.143346
	.031070	.096732	.161260	.172022	.080251
1.977778	-.175032	-.157115	-.066631	-.117484	-.143276
	.031434	.097874	.162889	.173963	.081010
1.955556	-.177008	-.159042	-.065387	-.119253	-.143165
	.031807	.099044	.164547	.175954	.081782
1.933333	-.179038	-.161030	-.064083	-.121063	-.143011
	.032190	.100244	.166235	.177996	.082568
1.911111	-.181124	-.163084	-.062716	-.122916	-.142813
	.032582	.101475	.167952	.180090	.083368
1.888889	-.183270	-.165207	-.061288	-.124812	-.142570
	.032984	.102737	.169701	.182239	.084183
1.866667	-.185479	-.167403	-.059797	-.126752	-.142282
	.033397	.104033	.171481	.184446	.085012
1.844444	-.187757	-.169679	-.058243	-.128739	-.141946
	.033821	.105363	.173293	.186711	.085857
1.822222	-.190108	-.172040	-.056626	-.130774	-.141562
	.034256	.106730	.175138	.189039	.086717
1.800000	-.192535	-.174490	-.054945	-.132858	-.141129
	.034702	.108133	.177016	.191430	.087593
1.777778	-.195046	-.177037	-.053199	-.134993	-.140644
	.035161	.109576	.178929	.193887	.088486
1.755556	-.197644	-.179687	-.051386	-.137183	-.140107
	.035633	.111059	.180877	.196414	.089395
1.733333	-.200335	-.182446	-.049501	-.139428	-.139514
	.036118	.112585	.182861	.199012	.090322
1.711111	-.203123	-.185322	-.047540	-.141730	-.138862
	.036616	.114155	.184882	.201685	.091266
1.688889	-.206014	-.188321	-.045495	-.144091	-.138147
	.037129	.115771	.186942	.204436	.092229
1.666667	-.209013	-.191452	-.043361	-.146514	-.137367
	.037658	.117436	.189039	.207268	.093209
1.644444	-.212126	-.194723	-.041129	-.149001	-.136516
	.038202	.119152	.191177	.210185	.094209
1.622222	-.215360	-.198144	-.038791	-.151554	-.135591
	.038763	.120921	.193356	.213190	.095228
1.600000	-.218721	-.201726	-.036337	-.154177	-.134586
	.039341	.122745	.195576	.216288	.096266
1.577778	-.222217	-.205479	-.033759	-.156873	-.133495
	.039938	.124629	.197840	.219482	.097325
1.555556	-.225857	-.209417	-.031044	-.159646	-.132313
	.040554	.126574	.200147	.222778	.098403
1.533333	-.229650	-.213554	-.028180	-.162498	-.131033
	.041191	.128584	.202499	.226179	.099503
1.511111	-.233605	-.217905	-.025153	-.165434	-.129643
	.041848	.130663	.204898	.229691	.100623
1.488889	-.237734	-.222485	-.021947	-.168459	-.128134
	.042528	.132813	.207344	.233321	.101765
1.466667	-.242049	-.227314	-.018546	-.171577	-.126492
	.043232	.135039	.209840	.237073	.102928
1.444444	-.246565	-.232412	-.014930	-.174793	-.124704
	.043961	.137345	.212388	.240954	.104113
1.422222	-.251296	-.237800	-.011079	-.178113	-.122752
	.044717	.139735	.214989	.244971	.105320
1.400000	-.256258	-.243504	-.006971	-.181543	-.120621
	.045500	.142214	.217645	.249131	.106548
1.377778	-.261469	-.249549	-.002580	-.185089	-.118290
	.046313	.144787	.220360	.253442	.107799
1.355556	-.266951	-.255960	.002119	-.188758	-.115738
	.047157	.147458	.223136	.257914	.109071
1.333333	-.272726	-.262788	.007157	-.192559	-.112942
	.048035	.150235	.225976	.262554	.110366
1.311111	-.278818	-.270051	.012565	-.196498	-.109875
	.048948	.153123	.228885	.267373	.111683
1.288889	-.285256	-.277794	.018374	-.200587	-.106509
	.049898	.156128	.231866	.272382	.113022
1.266667	-.292071	-.286059	.024619	-.204835	-.102813
	.050889	.159258	.234924	.277593	.114383
1.244444	-.299298	-.294896	.031337	-.209253	-.098754
	.051923	.162519	.238065	.283018	.115767
1.222222	-.306977	-.304352	.038566	-.213854	-.094292
	.053003	.165920	.241297	.288671	.117173
1.200000	-.315153	-.314483	.046346	-.218651	-.089384
	.054133	.169467	.244626	.294568	.118602
1.177778	-.323876	-.325346	.054717	-.223660	-.083982
	.055315	.173170	.248063	.300726	.120053

1.155556	-.333204	-.336999	.063720	-.228897	-.078032
	.056554	.177038	.251619	.307163	.121528
1.133333	-.343205	-.349504	.073394	-.234381	-.071473
	.057854	.181079	.255305	.313898	.123026
1.111111	-.353955	-.362922	.083775	-.240132	-.064235
	.059221	.185303	.259138	.320955	.124548
1.088889	-.365540	-.377314	.094897	-.246174	-.056240
	.060660	.189720	.263134	.328358	.126096
1.066667	-.378060	-.392738	.106786	-.252532	-.047399
	.062176	.194339	.267311	.336134	.127669
1.044444	-.391633	-.409250	.119462	-.259233	-.037608
	.063776	.199172	.271692	.344314	.129272
1.022222	-.406390	-.426902	.132938	-.266309	-.026754
	.065469	.204229	.276299	.352930	.130905
1.000000	-.422487	-.445742	.147219	-.273797	-.014708
	.067261	.209524	.281158	.362022	.132573
.977778	-.440101	-.465816	.162303	-.281737	-.001325
	.069162	.215069	.286294	.371632	.134283
.955556	-.459436	-.487167	.178181	-.290177	.013553
	.071182	.220881	.291736	.381808	.136040
.933333	-.480726	-.509841	.194840	-.299170	.030102
	.073332	.226976	.297515	.392604	.137856
.911111	-.504237	-.533889	.212266	-.308781	.048513
	.075624	.233373	.303661	.404083	.139745
.888889	-.530266	-.559370	.230445	-.319084	.068992
	.078072	.240097	.310209	.416316	.141723
.866667	-.559146	-.586354	.249365	-.330166	.091754
	.080688	.247172	.317194	.429384	.143813
.844444	-.591239	-.614933	.269021	-.342133	.117025
	.083489	.254629	.324656	.443384	.146045
.822222	-.626938	-.645216	.289416	-.355113	.145031
	.086492	.262503	.332640	.458424	.148452
.800000	-.666660	-.677343	.310563	-.369259	.176000
	.089714	.270833	.341195	.474637	.151074
.777778	-.710846	-.711485	.332494	-.384762	.210163
	.093174	.279665	.350380	.492177	.153959
.755556	-.759966	-.747850	.355258	-.401858	.247755
	.096896	.289054	.360262	.511228	.157158
.733333	-.814534	-.786697	.378936	-.420846	.289033
	.100904	.299058	.370925	.532013	.160728
.711111	-.875131	-.828339	.403645	-.442107	.334299
	.105229	.309751	.382466	.554806	.164729
.688889	-.942446	-.873162	.429561	-.466139	.383925
	.109908	.321214	.395009	.579945	.169226
.666667	-1.017331	-.921638	.456939	-.493605	.438398
	.114985	.333545	.408705	.607857	.174291
.644444	-1.100874	-.974350	.486151	-.525401	.498361
	.120518	.346857	.423748	.639087	.180001
.622222	-1.194492	-1.032027	.517741	-.562777	.564670
	.126577	.361288	.440385	.674352	.186448
.600000	-1.300057	-1.095584	.552502	-.607523	.638466
	.133252	.377000	.458937	.714613	.193740
.577778	-1.420074	-1.166185	.591600	-.662287	.721263
	.140655	.394193	.479826	.761206	.202010
.555556	-1.557935	-1.245328	.636755	-.731159	.815092
	.148935	.413110	.503615	.816055	.211422
.533333	-1.718323	-1.334975	.690532	-.820771	.922701
	.158284	.434055	.531068	.882071	.222191
.511111	-1.907846	-1.437737	.756819	-.942589	1.047887
	.168960	.457411	.563242	.963930	.234597
.488889	-2.136097	-1.557167	.841645	-1.118207	1.196020
	.181318	.483670	.601644	1.069774	.249021
.466667	-2.417527	-1.698211	.954686	-1.393552	1.374950
	.195862	.513483	.648486	1.215398	.265990
.444444	-2.774913	-1.867954	1.112234	-1.886347	1.596623
	.213337	.547726	.707184	1.436867	.286265
.422222	-3.246328	-2.076902	1.343715	-3.016557	1.880178
	.234902	.587616	.783366	1.843070	.310990
.400000	-3.900470	-2.341286	1.708064	-8.224655	2.258389
	.262483	.634917	.887218	3.081726	.341991
.377778	-4.875271	-2.687547	2.343321	1	2.792342
	.299595	.692302	1.039928	1	.382397
.355556	-6.494475	-3.161736	3.668144	1	3.610367
	.353573	.764086	1.296608	1	.438156
.333333	-9.739219	-3.851672	7.841573	1	5.035644
	.443469	.857813	1.881121	1	.522483
.311111	-19.636298	-4.947767	1	1	8.181988
	.646097	.988253	1	1	.673742

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                  I  1.189723          I          I  1.098467
 .266667          I-11.777976          I          I          I
                  I  1.570338          I          I          I
 .244444          I-38.360743          I          I          I
                  I   2.888418         I          I          I
 .222222          I          I         I          I          I
                  I          I         I          I          I
 .200000          I          I         I          I          I
                  I          I         I          I          I
 .177778          I          I         I          I          I
                  I          I         I          I          I
 .155556          I          I         I          I          I
                  I          I         I          I          I
 .133333          I          I         I          I          I
                  I          I         I          I          I
 .111111          I          I         I          I          I
                  I          I         I          I          I
 .088889          I          I         I          I          I
                  I          I         I          I          I
 .066667          I          I         I          I          I
                  I          I         I          I          I
 .044444          I          I         I          I          I
                  I          I         I          I          I
 .022222          I          I         I          I          I
                  I          I         I          I          I
0.000000          I          I         I          I          I
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VF=       1.36747767E-01     OMEGA=       1.28665945E+01

Z =     -792.4  ICODE =   0
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REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

DENSITY PARAMETER = 3.31396706852995+02

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	.031435	.097871	.162969	.173990	.081071
1.955556	-.175513	-.157674	-.065477	-.118023	-.142469
	.031808	.099041	.164631	.175979	.081845
1.933333	-.177523	-.159641	-.064191	-.119818	-.142348
	.032190	.100241	.166321	.178019	.082633
1.911111	-.179533	-.161672	-.062844	-.121656	-.142165
	.032583	.101471	.168042	.180112	.083435
1.888889	-.181715	-.163772	-.061435	-.123537	-.141937
	.032985	.102733	.169794	.182260	.084251
1.866667	-.183901	-.165945	-.059964	-.125463	-.141665
	.033397	.104028	.171577	.184465	.085082
1.844444	-.186156	-.168196	-.058431	-.127435	-.141346
	.033821	.105357	.173393	.186729	.085928
1.822222	-.188483	-.170530	-.056835	-.129455	-.140980
	.034255	.106723	.175241	.189054	.086790
1.800000	-.190887	-.172953	-.055175	-.131524	-.140566
	.034702	.108126	.177123	.191444	.087668
1.777778	-.193372	-.175471	-.053452	-.133644	-.140101
	.035161	.109568	.179040	.193899	.088563
1.755556	-.195944	-.178091	-.051662	-.135818	-.139584
	.035632	.111050	.180991	.196424	.089475
1.733333	-.198607	-.180819	-.049801	-.138048	-.139013
	.036116	.112575	.182979	.199021	.090404
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	.036615	.114144	.185004	.201692	.091350
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1.666667	-.207196	-.189721	-.043740	-.145085	-.136939
	.037656	.117423	.189169	.207271	.093298
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	.038200	.119138	.191311	.210186	.094300
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	.038760	.120905	.193494	.213189	.095322
1.600000	-.216802	-.199874	-.036809	-.152694	-.134244
	.039339	.122729	.195719	.216284	.096363
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	.040550	.126555	.200298	.222769	.098506
1.533333	-.227613	-.211561	-.028762	-.160955	-.130791
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	.041844	.130641	.205057	.229677	.100732
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	.043227	.135014	.210009	.237053	.103044
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	.043955	.137318	.212561	.240930	.104232
1.422222	-.249018	-.235510	-.011895	-.176450	-.122724
	.044710	.139706	.215166	.244944	.105442
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	.045492	.142183	.217827	.249100	.106674
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	.046304	.144754	.220546	.253408	.107929
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	.048024	.150198	.226170	.262510	.110504
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	.048936	.153084	.229081	.267324	.111826
1.288889	-.282580	-.275006	.017170	-.198739	-.106847
	.049886	.156087	.232065	.272328	.113169
1.266667	-.289312	-.283170	.023338	-.202950	-.103228
	.050876	.159215	.235126	.277533	.114535
1.244444	-.296450	-.291899	.029975	-.207330	-.099251
	.051908	.162474	.238269	.282952	.115923
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1.200000	-.312105	-.311256	.044812	-.216643	-.090066
	.054115	.169418	.244830	.294488	.118767
1.177778	-.320716	-.321995	.053094	-.221606	-.084767
	.055295	.173120	.248265	.300638	.120224

1.155556	-.329924	-.333520	.062006	-.226795	-.078928
	.056533	.176986	.251818	.307066	.121703
1.133333	-.339794	-.345893	.071590	-.232227	-.072488
	.057831	.181027	.255500	.313792	.123206
1.111111	-.350400	-.359177	.081882	-.237923	-.065379
	.059196	.185250	.259327	.320839	.124732
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	.060632	.189667	.263315	.328230	.126284
1.066667	-.374181	-.388720	.104725	-.250201	-.048833
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	.065432	.204182	.276447	.352760	.131103
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	.067221	.209479	.281291	.361835	.132774
.977778	-.435364	-.461270	.159992	-.279103	-.003485
	.069119	.215028	.286412	.371426	.134484
.955556	-.454431	-.482498	.175832	-.287450	.011178
	.071136	.220843	.291838	.381580	.136240
.933333	-.475427	-.505052	.192463	-.296344	.027498
	.073282	.226942	.297600	.392352	.138054
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	.075570	.233344	.303729	.403804	.139937
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	.078013	.240071	.310258	.416006	.141907
.866667	-.552803	-.581211	.246962	-.326976	.088393
	.080626	.247150	.317225	.429040	.143987
.844444	-.584495	-.609666	.266625	-.338796	.113394
	.083423	.254610	.324669	.443000	.146204
.822222	-.619767	-.639820	.287033	-.351610	.141127
	.086422	.262487	.332633	.457995	.148593
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	.089640	.270819	.341169	.474156	.151193
.777778	-.702753	-.705796	.330149	-.380863	.205716
	.093097	.279653	.350333	.491634	.154053
.755556	-.751382	-.741993	.352934	-.397717	.243041
	.096815	.289042	.360193	.510614	.157223
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	.109814	.321195	.394854	.579027	.169188
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	.120411	.346825	.423504	.637842	.179884
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.577778	-1.405460	-1.157722	.588779	-.653226	.713547
	.140504	.394119	.479332	.759059	.201755
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	.148758	.413013	.502980	.813387	.211111
.533333	-1.700409	-1.325116	.686713	-.807593	.913280
	.158073	.433928	.530244	.878663	.221816
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	.168703	.457244	.562161	.959415	.234147
.488889	-2.112695	-1.545204	.835439	-1.095186	1.183774
	.180999	.483453	.600204	1.063473	.248479
.466667	-2.389865	-1.684766	.946202	-1.359086	1.360550
	.195456	.513199	.646535	1.205900	.265331
.444444	-2.741200	-1.852587	1.100060	-1.826008	1.579231
	.212805	.547349	.704481	1.420612	.285451
.422222	-3.203554	-2.058968	1.325241	-2.871619	1.858446
	.234181	.587112	.779490	1.807406	.309962
.400000	-3.843125	-2.319806	1.677839	-7.277164	2.229983
	.261463	.634229	.881363	2.914064	.340650
.377778	-4.791970	-2.660935	2.287644	I	2.752815
	.298057	.691340	1.030259	I	.380563
.355556	-6.357020	-3.127238	3.539920	I	3.549993
	.351015	.762689	1.277654	I	.435462
.333333	-9.452620	-3.803976	7.321519	I	4.928093
	.438386	.855679	1.823925	I	.518026
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	.630504	.984724	11.774598	I	.664441

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 .266667         I-11.439673         I         I         I
                 I  1.553860         I         I         I
 .244444         I-35.749495         I         I         I
                 I  2.781806         I         I         I
 .222222         I         I         I         I         I
                 I         I         I         I         I
 .200000         I         I         I         I         I
                 I         I         I         I         I
 .177778         I         I         I         I         I
                 I         I         I         I         I
 .155556         I         I         I         I         I
                 I         I         I         I         I
 .133333         I         I         I         I         I
                 I         I         I         I         I
 .111111         I         I         I         I         I
                 I         I         I         I         I
 .088889         I         I         I         I         I
                 I         I         I         I         I
 .066667         I         I         I         I         I
                 I         I         I         I         I
 .044444         I         I         I         I         I
                 I         I         I         I         I
 .022222         I         I         I         I         I
                 I         I         I         I         I
0.000000         I         I         I         I         I
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VF=      1.37220472E-01     OMEGA=       1.28850076E+01

Z =    -780.8 ICODE =   0
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FLUTTER CONDITION NO. 2

01/16/74 DAMPING - VELOCITY/((REF LENGTH)*(REF FREQUENCY))

DENSITY PARAMETER = 2.26987206529 7E+02

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2.432432	-.096962	-.136594	-.090737	-.090604	-.104024
	.025583	.071230	.079874	.135009	.144120
2.399103	-.098211	-.139267	-.092696	-.090668	-.104488
	.025950	.072156	.081007	.136789	.146058
2.366071	-.099480	-.141999	-.094683	-.090675	-.104951
	.026324	.073095	.082162	.138598	.148031
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	.026707	.074049	.083339	.140436	.150041
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	.027097	.075017	.084539	.142305	.152087
2.268722	-.103471	-.150536	-.100766	-.090395	-.106350
	.027496	.075999	.085761	.144205	.154171
2.236842	-.104882	-.153488	-.102818	-.090225	-.106821
	.027902	.076996	.087007	.146136	.156293
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	.028318	.078006	.088278	.148099	.158454
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	.028742	.079030	.089572	.150094	.160654
2.142857	-.109452	-.162609	-.108965	-.089589	-.108264
	.029175	.080068	.090893	.152123	.162895
2.112069	-.111107	-.165720	-.110999	-.089346	-.108766
	.029617	.081119	.092239	.154186	.165178
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	.030531	.083264	.095017	.158412	.169881
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	.031485	.085468	.097917	.162775	.174785
1.962025	-.120342	-.181504	-.121098	-.087458	-.111778
	.031979	.086592	.099418	.165008	.177321
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	.032484	.087733	.100954	.167275	.179917
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	.034627	.092467	.107498	.176693	.190989
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1.762295	-.135522	-.202629	-.135850	-.080860	-.118931
	.035780	.094939	.111034	.181619	.196984
1.734694	-.137907	-.205385	-.138114	-.079443	-.120283
	.036379	.096201	.112874	.184142	.200103
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	.036993	.097478	.114764	.186706	.203308
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	.037623	.098770	.116705	.189315	.206598
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	.038270	.100076	.118699	.191969	.209977
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	.038935	.101395	.120748	.194671	.213446
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1.547619	-.157153	-.221023	-.156038	-.066324	-.131479
	.041043	.105413	.127245	.203091	.224415
1.521739	-.160379	-.222538	-.159004	-.063962	-.133307
	.041786	.106772	.129536	.206006	.228271
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	.042552	.108142	.131896	.208976	.232236

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	.044153	.110916	.136835	.215083	.240515
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	.188991	.241532	.506382	.579759	.955702
.445545	-1.839074	.938086	-1.305817	.676075	-.642820
	.200661	.253894	.531531	.609181	1.026160
.427632	-2.042229	1.062780	-1.405283	.732253	-.723601
	.213335	.267945	.559331	.643031	1.110991
.409836	-2.284461	1.208009	-1.519856	.802259	-.834840
	.229062	.284036	.590281	.682541	1.216406
.392157	-2.579734	1.380308	-1.653725	.892503	-.997732
	.246746	.302656	.625029	.729430	1.353386
.374593	-2.949538	1.589260	-1.812737	1.012978	-1.258194
	.267740	.324475	.664426	.786171	1.543681
.357143	-3.428732	1.849534	-2.005303	1.180014	-1.737697
	.293262	.350477	.709632	.850493	1.838409
.339806	-4.077864	2.184797	-2.243940	1.422104	-2.898522
	.325271	.382146	.762272	.946369	2.400562
.322581	-5.012172	2.635905	-2.548105	1.793910	-9.582944
	.367181	.421868	.824724	1.066242	4.404704
.305466	-6.481345	3.279984	-2.949721	2.415988	I
	.425648	.473781	.900632	1.236789	I
.288462	-9.146335	4.282247	-3.505010	3.619325	I
	.516084	.545886	.995954	1.507526	I
.271565	-15.518703	6.071824	-4.322862	6.767300	I
	.686986	.656449	1.121278	2.045595	I
.254777	-51.545805	10.218647	-5.645096	32.614710	I
	1.281164	.861228	1.297793	4.441456	I
.238095	I	30.731147	-8.137672	I	I
	I	1.512328	1.576480	I	I
.221519	I	I	-14.544284	I	I
	I	I	2.129635	I	I
.205047	I	I	-66.455343	I	I
	I	I	4.593399	I	I
.188679	I	I	I	I	I
	I	I	I	I	I
.172414	I	I	I	I	I
	I	I	I	I	I
.156250	I	I	I	I	I
	I	I	I	I	I
.140187	I	I	I	I	I
	I	I	I	I	I
.124224	I	I	I	I	I
	I	I	I	I	I
.108359	I	I	I	I	I
	I	I	I	I	I
.092593	I	I	I	I	I
	I	I	I	I	I
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	I	I	I	I	I
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VF= 1.63514895E-01 OMEGA= 1.17379007E+01

Z = 3274.2 ICODE = 0

DENSITY PARAMETER = 2.217457116997E+02

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	.025224	.070357	.078747	.133352	.142298
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	.025951	.072198	.080991	.136893	.146139
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	.027097	.075066	.084521	.142426	.152169
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	.027495	.076051	.085742	.144332	.154253
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	.029173	.080132	.090871	.152278	.162976
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	.036367	.096346	.112833	.184447	.200161
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	.036981	.097631	.114720	.187026	.203361
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	.043316	.109781	.134248	.212473	.236320
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	.044126	.111190	.136750	.215573	.240513
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1.346154	-.182205	-.223592	-.179239	-.044167	-.144691
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	.050588	.121516	.156800	.238868	.273857
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	.052738	.124640	.163513	.246050	.284914
1.203008	-.210746	-.217435	-.208827	-.018927	-.161040
	.053874	.126230	.167067	.249735	.290742
1.179775	-.216298	-.215302	-.214959	-.013680	-.164176
	.055054	.127837	.170763	.253484	.296784
1.156716	-.222141	-.212800	-.221540	-.008050	-.167446
	.056281	.129461	.174608	.257300	.303051
1.133829	-.228305	-.209902	-.228622	-.001998	-.170858
	.057558	.131101	.178613	.261185	.309555
1.111111	-.234827	-.206578	-.236263	.004523	-.174421
	.058888	.132754	.182786	.265144	.316311
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	.060277	.134419	.187138	.269180	.323332
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	.061727	.136094	.191680	.273300	.330636
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	.063243	.137777	.196424	.277512	.338240
1.021898	-.265363	-.188200	-.273807	.036385	-.190381
	.064831	.139467	.201379	.281824	.346163
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	.066496	.141161	.206560	.286251	.354428
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	.072025	.146241	.223563	.300400	.381517
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	.076237	.149606	.236223	.310806	.401783
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	.095840	.161520	.290261	.357631	.491917
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	.099471	.163451	.299447	.366113	.508050
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	.103362	.165562	.309085	.375149	.525255
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	.116720	.173706	.341149	.406017	.584618
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	.127170	.181405	.365717	.430304	.632388
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	.160643	.212152	.443220	.510006	.797988
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	.169143	.220794	.462487	.530703	.843375
.481728	-1.509748	.730520	-1.137944	.588761	-.530787
	.178506	.230498	.483432	.553724	.895084
.463576	-1.659785	.826500	-1.215439	.628539	-.578868
	.188903	.241419	.506314	.579580	.954819
.445545	-1.832662	.934979	-1.302619	.674976	-.639796
	.200557	.253760	.531449	.608946	1.025053
.427632	-2.034962	1.059294	-1.401777	.730918	-.719838
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	.246554	.302427	.624877	.728879	1.350673
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.357143	-3.413589	1.842794	-1.999540	1.175694	-1.718241
	.292938	.350130	.709389	.855469	1.831006
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	.324827	.381705	.761958	.944920	2.383175
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.305466	-6.437029	3.263796	-2.939207	2.398114	I
	.424643	.472972	.900062	1.233374	I
.288462	-9.063583	4.256803	-3.491071	3.581785	I
	.514288	.544672	.995142	1.501267	I
.271565	-15.295782	5.024519	-4.303057	6.648529	I
	.682751	.554374	1.120053	2.029894	I
.254777	-49.299374	10.094672	-5.613760	3C.300341	I
	1.254248	.856624	1.295780	4.286256	I
.238095	I	29.709010	-8.077798	I	I
	I	1.488074	1.572647	I	I
.221519	I	I	-14.370724	I	I
	I	I	2.119610	I	I
.205047	I	I	-63.311115	I	I
	I	I	4.489288	I	I
.188679	I	I	I	I	I
	I	I	I	I	I
.172414	I	I	I	I	I
	I	I	I	I	I
.156250	I	I	I	I	I
	I	I	I	I	I
.140187	I	I	I	I	I
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VF= 1.63692760E-01 OMEGA= 1.17440375E+01

Z = 3277.5 ICODE = 0

FLUTTER CONDITION NO. 3

OMEGA RADIANS/SEC.	V	DETERMINANT REAL PART	DETERMINANT IMAGINARY PART
0.	1.50000000E+04	-4.49040762E+13	0.
0.	1.60000000E+04	-4.91073761E+13	0.
0.	1.70000000E+04	-5.35720599E+13	0.
0.	1.80000000E+04	-5.83086551E+13	0.
0.	1.90000000E+04	-6.33279344E+13	0.
0.	2.00000000E+04	-6.86409172E+13	0.
0.	2.10000000E+04	-7.42588711E+13	0.
0.	2.20000000E+04	-8.01933133E+13	0.
0.	2.30000000E+04	-8.64560121E+13	0.
0.	2.40000000E+04	-9.30589882E+13	0.
0.	2.50000000E+04	-1.00014516E+14	0.
0.	2.60000000E+04	-1.07335124E+14	0.
0.	2.70000000E+04	-1.15033597E+14	0.
0.	2.80000000E+04	-1.23122977E+14	0.
0.	2.90000000E+04	-1.31616564E+14	0.
0.	3.00000000E+04	-1.40527916E+14	0.
0.	3.10000000E+04	-1.49870852E+14	0.
0.	3.20000000E+04	-1.59659450E+14	0.
0.	3.30000000E+04	-1.69908050E+14	0.
0.	3.40000000E+04	-1.80631253E+14	0.
0.	3.50000000E+04	-1.91843925E+14	0.
0.	3.60000000E+04	-2.03561191E+14	0.
0.	3.70000000E+04	-2.15798442E+14	0.
0.	3.80000000E+04	-2.28571331E+14	0.
0.	3.90000000E+04	-2.41895777E+14	0.
0.	4.00000000E+04	-2.55787961E+14	0.
1.00000000E+00	1.50000000E+04	-4.42270389E+13	-1.89774567E+12
1.00000000E+00	1.60000000E+04	-4.83914411E+13	-1.99437158E+12
1.00000000E+00	1.70000000E+04	-5.28158839E+13	-2.09417792E+12
1.00000000E+00	1.80000000E+04	-5.75108727E+13	-2.19722506E+12
1.00000000E+00	1.90000000E+04	-6.24871578E+13	-2.30357368E+12
1.00000000E+00	2.00000000E+04	-6.77557362E+13	-2.41328478E+12
1.00000000E+00	2.10000000E+04	-7.33278533E+13	-2.52641964E+12
1.00000000E+00	2.20000000E+04	-7.92150037E+13	-2.64303984E+12
1.00000000E+00	2.30000000E+04	-8.54289334E+13	-2.76320721E+12
1.00000000E+00	2.40000000E+04	-9.19816405E+13	-2.88698386E+12
1.00000000E+00	2.50000000E+04	-9.88853767E+13	-3.01443214E+12
1.00000000E+00	2.60000000E+04	-1.06152648E+14	-3.14561463E+12
1.00000000E+00	2.70000000E+04	-1.13796218E+14	-3.28059414E+12
1.00000000E+00	2.80000000E+04	-1.21829105E+14	-3.41943368E+12
1.00000000E+00	2.90000000E+04	-1.30264586E+14	-3.56219649E+12
1.00000000E+00	3.00000000E+04	-1.39116198E+14	-3.70894596E+12
1.00000000E+00	3.10000000E+04	-1.48397736E+14	-3.85974568E+12
1.00000000E+00	3.20000000E+04	-1.58123255E+14	-4.01465940E+12
1.00000000E+00	3.30000000E+04	-1.68307074E+14	-4.17375102E+12
1.00000000E+00	3.40000000E+04	-1.78963772E+14	-4.33708456E+12
1.00000000E+00	3.50000000E+04	-1.90108189E+14	-4.50472420E+12
1.00000000E+00	3.60000000E+04	-2.01755430E+14	-4.67673422E+12
1.00000000E+00	3.70000000E+04	-2.13920863E+14	-4.85317898E+12
1.00000000E+00	3.80000000E+04	-2.26620119E+14	-5.03412297E+12
1.00000000E+00	3.90000000E+04	-2.39869092E+14	-5.21963074E+12
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2.00000000E+00	1.50000000E+04	-4.22316536E+13	-3.69111472E+12
2.00000000E+00	1.60000000E+04	-4.62807061E+13	-3.88087995E+12
2.00000000E+00	1.70000000E+04	-5.05857933E+13	-4.07695025E+12
2.00000000E+00	1.80000000E+04	-5.51573537E+13	-4.27944636E+12
2.00000000E+00	1.90000000E+04	-6.00060706E+13	-4.48848963E+12
2.00000000E+00	2.00000000E+04	-6.51428740E+13	-4.70420206E+12
2.00000000E+00	2.10000000E+04	-7.05789419E+13	-4.92670623E+12
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2.00000000E+00	2.50000000E+04	-9.55481820E+13	-5.88711144E+12
2.00000000E+00	2.60000000E+04	-1.02657024E+14	-6.14543220E+12
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2.00000000E+00	2.90000000E+04	-1.26265331E+14	-6.96612970E+12
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4.00000000E+00	4.00000000E+04	-2.23626432E+14	-1.96084813E+13
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5.00000000E+00	2.00000000E+04	-4.85725387E+13	-9.74963214E+12
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6.00000000E+00	1.70000000E+04	-3.01684658E+13	-8.99142510E+12
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8.00000000E+00	3.80000000E+04	-1.26180642E+14	-2.56148474E+13
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9.00000000E+00	2.20000000E+04	-2.26969577E+13	-1.10144802E+13
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9.00000000E+00	2.40000000E+04	-2.90641261E+13	-1.23762606E+13
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9.00000000E+00	3.00000000E+04	-5.43170855E+13	-1.71163594E+13
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9.00000000E+00	3.60000000E+04	-9.07442636E+13	-2.29345894E+13
9.00000000E+00	3.70000000E+04	-9.80922863E+13	-2.40179027E+13
9.00000000E+00	3.80000000E+04	-1.05841032E+14	-2.51352380E+13
9.00000000E+00	3.90000000E+04	-1.14004560E+14	-2.62871845E+13
9.00000000E+00	4.00000000E+04	-1.22597191E+14	-2.74743327E+13
1.00000000E+01	1.50000000E+04	-2.00541120E+12	-5.89835473E+12
1.00000000E+01	1.60000000E+04	-3.31953534E+12	-6.37479904E+12
1.00000000E+01	1.70000000E+04	-4.77962011E+12	-6.87420157E+12
1.00000000E+01	1.80000000E+04	-6.39396650E+12	-7.39715567E+12
1.00000000E+01	1.90000000E+04	-8.17111534E+12	-7.94425892E+12
1.00000000E+01	2.00000000E+04	-1.01198491E+13	-8.51611292E+12
1.00000000E+01	2.10000000E+04	-1.22491934E+13	-9.11332323E+12
1.00000000E+01	2.20000000E+04	-1.45684190E+13	-9.73649925E+12
1.00000000E+01	2.30000000E+04	-1.70870429E+13	-1.03862540E+13
1.00000000E+01	2.40000000E+04	-1.98148302E+13	-1.10632043E+13
1.00000000E+01	2.50000000E+04	-2.27617951E+13	-1.17679701E+13
1.00000000E+01	2.60000000E+04	-2.59382029E+13	-1.25011750E+13
1.00000000E+01	2.70000000E+04	-2.93545707E+13	-1.32634455E+13
1.00000000E+01	2.80000000E+04	-3.30216687E+13	-1.40554115E+13
1.00000000E+01	2.90000000E+04	-3.69505219E+13	-1.48777056E+13
1.00000000E+01	3.00000000E+04	-4.11524102E+13	-1.57309634E+13
1.00000000E+01	3.10000000E+04	-4.56388705E+13	-1.66158231E+13
1.00000000E+01	3.20000000E+04	-5.04216969E+13	-1.75329256E+13
1.00000000E+01	3.30000000E+04	-5.55129417E+13	-1.84829141E+13
1.00000000E+01	3.40000000E+04	-6.09249165E+13	-1.94664343E+13
1.00000000E+01	3.50000000E+04	-6.66701927E+13	-2.04841340E+13
1.00000000E+01	3.60000000E+04	-7.27616022E+13	-2.15366631E+13
1.00000000E+01	3.70000000E+04	-7.92122382E+13	-2.26246735E+13
1.00000000E+01	3.80000000E+04	-8.60354552E+13	-2.37488188E+13
1.00000000E+01	3.90000000E+04	-9.32448700E+13	-2.49097543E+13
1.00000000E+01	4.00000000E+04	-1.00854362E+14	-2.61081371E+13
1.10000000E+01	1.50000000E+04	2.00353786E+12	-4.49743600E+12
1.10000000E+01	1.60000000E+04	1.07253865E+12	-4.93077366E+12
1.10000000E+01	1.70000000E+04	1.51532622E+10	-5.38741334E+12
1.10000000E+01	1.80000000E+04	-1.17645673E+12	-5.86800285E+12
1.10000000E+01	1.90000000E+04	-2.51036787E+12	-6.37319483E+12
1.10000000E+01	2.00000000E+04	-3.99489662E+12	-6.90364665E+12
1.10000000E+01	2.10000000E+04	-5.63860109E+12	-7.46002026E+12
1.10000000E+01	2.20000000E+04	-7.45028268E+12	-8.04298205E+12
1.10000000E+01	2.30000000E+04	-9.43898773E+12	-8.65320274E+12
1.10000000E+01	2.40000000E+04	-1.16140090E+13	-9.29135721E+12
1.10000000E+01	2.50000000E+04	-1.39848872E+13	-9.95812439E+12
1.10000000E+01	2.60000000E+04	-1.65614124E+13	-1.06541871E+13
1.10000000E+01	2.70000000E+04	-1.93536251E+13	-1.13802320E+13
1.10000000E+01	2.80000000E+04	-2.23718180E+13	-1.21369492E+13
1.10000000E+01	2.90000000E+04	-2.56265367E+13	-1.29250326E+13
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1.10000000E+01	3.10000000E+04	-3.28890064E+13	-1.45980891E+13
1.10000000E+01	3.20000000E+04	-3.69191242E+13	-1.54844659E+13
1.10000000E+01	3.30000000E+04	-4.12305031E+13	-1.64050159E+13
1.10000000E+01	3.40000000E+04	-4.58349698E+13	-1.73604481E+13
1.10000000E+01	3.50000000E+04	-5.07446101E+13	-1.83514743E+13

1.10000000E+01	3.60000000E+04	-5.59717690E+13	-1.93788087E+13
1.10000000E+01	3.70000000E+04	-6.15290520E+13	-2.04431680E+13
1.10000000E+01	3.80000000E+04	-6.74293251E+13	-2.15452710E+13
1.10000000E+01	3.90000000E+04	-7.36857159E+13	-2.26858387E+13
1.10000000E+01	4.00000000E+04	-8.03116134E+13	-2.38655939E+13
1.20000000E+01	1.50000000E+04	4.98258630E+12	-2.91760076E+12
1.20000000E+01	1.60000000E+04	4.39719586E+12	-3.29146840E+12
1.20000000E+01	1.70000000E+04	3.70509222E+12	-3.68847734E+12
1.20000000E+01	1.80000000E+04	2.89893964E+12	-4.10932731E+12
1.20000000E+01	1.90000000E+04	1.97116640E+12	-4.55472362E+12
1.20000000E+01	2.00000000E+04	9.13962973E+11	-5.02537704E+12
1.20000000E+01	2.10000000E+04	-2.80719795E+11	-5.52200363E+12
1.20000000E+01	2.20000000E+04	-1.62117237E+12	-6.04532460E+12
1.20000000E+01	2.30000000E+04	-3.11592821E+12	-6.59606614E+12
1.20000000E+01	2.40000000E+04	-4.77376533E+12	-7.17495932E+12
1.20000000E+01	2.50000000E+04	-6.60370782E+12	-7.78273990E+12
1.20000000E+01	2.60000000E+04	-8.61502735E+12	-8.42014819E+12
1.20000000E+01	2.70000000E+04	-1.08172445E+13	-9.08792888E+12
1.20000000E+01	2.80000000E+04	-1.32201300E+13	-9.78683095E+12
1.20000000E+01	2.90000000E+04	-1.58337062E+13	-1.05176074E+13
1.20000000E+01	3.00000000E+04	-1.86682482E+13	-1.12810153E+13
1.20000000E+01	3.10000000E+04	-2.17342845E+13	-1.20778154E+13
1.20000000E+01	3.20000000E+04	-2.50425989E+13	-1.29087722E+13
1.20000000E+01	3.30000000E+04	-2.86042307E+13	-1.37746535E+13
1.20000000E+01	3.40000000E+04	-3.24304760E+13	-1.46762305E+13
1.20000000E+01	3.50000000E+04	-3.65328884E+13	-1.56142778E+13
1.20000000E+01	3.60000000E+04	-4.09232799E+13	-1.65895726E+13
1.20000000E+01	3.70000000E+04	-4.56137214E+13	-1.76028954E+13
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1.20000000E+01	3.90000000E+04	-5.59443366E+13	-1.97467591E+13
1.20000000E+01	4.00000000E+04	-6.16099525E+13	-2.08788736E+13
1.30000000E+01	1.50000000E+04	6.82886783E+12	-1.27625851E+12
1.30000000E+01	1.60000000E+04	6.53938217E+12	-1.57668856E+12
1.30000000E+01	1.70000000E+04	6.16252821E+12	-1.89957547E+12
1.30000000E+01	1.80000000E+04	5.69151080E+12	-2.24566768E+12
1.30000000E+01	1.90000000E+04	5.11930149E+12	-2.61572003E+12
1.30000000E+01	2.00000000E+04	4.43863655E+12	-3.01049360E+12
1.30000000E+01	2.10000000E+04	3.64201519E+12	-3.43075560E+12
1.30000000E+01	2.20000000E+04	2.72169774E+12	-3.87727915E+12
1.30000000E+01	2.30000000E+04	1.66970395E+12	-4.35084312E+12
1.30000000E+01	2.40000000E+04	4.77811315E+11	-4.85223203E+12
1.30000000E+01	2.50000000E+04	-8.62446470E+11	-5.38223580E+12
1.30000000E+01	2.60000000E+04	-2.35978105E+12	-5.94164966E+12
1.30000000E+01	2.70000000E+04	-4.02315083E+12	-6.53127395E+12
1.30000000E+01	2.80000000E+04	-5.86176241E+12	-7.15191393E+12
1.30000000E+01	2.90000000E+04	-7.88507180E+12	-7.80437968E+12
1.30000000E+01	3.00000000E+04	-1.01027858E+13	-8.48948587E+12
1.30000000E+01	3.10000000E+04	-1.25248630E+13	-9.20805163E+12
1.30000000E+01	3.20000000E+04	-1.51615149E+13	-9.96090036E+12
1.30000000E+01	3.30000000E+04	-1.80232074E+13	-1.07488596E+13
1.30000000E+01	3.40000000E+04	-2.11206609E+13	-1.15727608E+13
1.30000000E+01	3.50000000E+04	-2.44648519E+13	-1.24334391E+13
1.30000000E+01	3.60000000E+04	-2.80670135E+13	-1.33317335E+13
1.30000000E+01	3.70000000E+04	-3.19386366E+13	-1.42684862E+13
1.30000000E+01	3.80000000E+04	-3.60914697E+13	-1.52445427E+13
1.30000000E+01	3.90000000E+04	-4.05375204E+13	-1.62607516E+13
1.30000000E+01	4.00000000E+04	-4.52890554E+13	-1.73179645E+13
1.40000000E+01	1.50000000E+04	7.52116757E+12	2.98521415E+11
1.40000000E+01	1.60000000E+04	7.46770990E+12	8.23718368E+10
1.40000000E+01	1.70000000E+04	7.34546278E+12	-1.55015813E+11
1.40000000E+01	1.80000000E+04	7.14820673E+12	-4.14434565E+11
1.40000000E+01	1.90000000E+04	6.86949219E+12	-6.96684782E+11
1.40000000E+01	2.00000000E+04	6.50263748E+12	-1.00257398E+12
1.40000000E+01	2.10000000E+04	6.04072694E+12	-1.33291668E+12
1.40000000E+01	2.20000000E+04	5.47660902E+12	-1.68853418E+12
1.40000000E+01	2.30000000E+04	4.80289452E+12	-2.07025443E+12
1.40000000E+01	2.40000000E+04	4.01195489E+12	-2.47891183E+12
1.40000000E+01	2.50000000E+04	3.09592051E+12	-2.91534707E+12
1.40000000E+01	2.60000000E+04	2.04667919E+12	-3.38040692E+12
1.40000000E+01	2.70000000E+04	8.55874592E+11	-3.87494408E+12
1.40000000E+01	2.80000000E+04	-4.85095212E+11	-4.39981697E+12
1.40000000E+01	2.90000000E+04	-1.98507909E+12	-4.95588961E+12
1.40000000E+01	3.00000000E+04	-3.65317420E+12	-5.54403135E+12
1.40000000E+01	3.10000000E+04	-5.49872718E+12	-6.16511677E+12
1.40000000E+01	3.20000000E+04	-7.53133539E+12	-6.82002544E+12
1.40000000E+01	3.30000000E+04	-9.76084796E+12	-7.50964178E+12
1.40000000E+01	3.40000000E+04	-1.21973668E+13	-8.23485483E+12
1.40000000E+01	3.50000000E+04	-1.48512478E+13	-8.99655812E+12
1.40000000E+01	3.60000000E+04	-1.77331011E+13	-9.79564944E+12

1.40000000E+01	3.70000000E+04	-2.08537929E+13	-1.06330307E+13
1.40000000E+01	3.80000000E+04	-2.42244451E+13	-1.15096076E+13
1.40000000E+01	3.90000000E+04	-2.78564370E+13	-1.24262898E+13
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1.50000000E+01	1.50000000E+04	7.12557075E+12	1.67549210E+12
1.50000000E+01	1.60000000E+04	7.24064106E+12	1.55067089E+12
1.50000000E+01	1.70000000E+04	7.30429299E+12	1.40636557E+12
1.50000000E+01	1.80000000E+04	7.31091416E+12	1.24174361E+12
1.50000000E+01	1.90000000E+04	7.25466599E+12	1.05596414E+12
1.50000000E+01	2.00000000E+04	7.12948162E+12	8.48178105E+11
1.50000000E+01	2.10000000E+04	6.92906390E+12	6.17528470E+11
1.50000000E+01	2.20000000E+04	6.64688348E+12	3.63150419E+11
1.50000000E+01	2.30000000E+04	6.27617689E+12	8.41715341E+10
1.50000000E+01	2.40000000E+04	5.80994479E+12	-2.20288008E+11
1.50000000E+01	2.50000000E+04	5.24095019E+12	-5.51115245E+11
1.50000000E+01	2.60000000E+04	4.56171682E+12	-9.09204236E+11
1.50000000E+01	2.70000000E+04	3.76452751E+12	-1.29545586E+12
1.50000000E+01	2.80000000E+04	2.84142265E+12	-1.71077765E+12
1.50000000E+01	2.90000000E+04	1.78419876E+12	-2.15608353E+12
1.50000000E+01	3.00000000E+04	5.84407060E+11	-2.63229372E+12
1.50000000E+01	3.10000000E+04	-7.66647809E+11	-3.14033443E+12
1.50000000E+01	3.20000000E+04	-2.27790908E+12	-3.68113776E+12
1.50000000E+01	3.30000000E+04	-3.95856901E+12	-4.25564142E+12
1.50000000E+01	3.40000000E+04	-5.81807003E+12	-4.86478860E+12
1.50000000E+01	3.50000000E+04	-7.86610573E+12	-5.50952770E+12
1.50000000E+01	3.60000000E+04	-1.01126219E+13	-6.19081221E+12
1.50000000E+01	3.70000000E+04	-1.25678173E+13	-6.90960045E+12
1.50000000E+01	3.80000000E+04	-1.52421448E+13	-7.66685536E+12
1.50000000E+01	3.90000000E+04	-1.81463117E+13	-8.46354438E+12
1.50000000E+01	4.00000000E+04	-2.12912807E+13	-9.30063915E+12
1.60000000E+01	1.50000000E+04	5.79599442E+12	2.72875829E+12
1.60000000E+01	1.60000000E+04	6.00750272E+12	2.69793594E+12
1.60000000E+01	1.70000000E+04	6.18331906E+12	2.64990807E+12
1.60000000E+01	1.80000000E+04	6.31846500E+12	2.58380891E+12
1.60000000E+01	1.90000000E+04	6.40774059E+12	2.49876323E+12
1.60000000E+01	2.00000000E+04	6.44572216E+12	2.39388649E+12
1.60000000E+01	2.10000000E+04	6.42676024E+12	2.26828505E+12
1.60000000E+01	2.20000000E+04	6.34497753E+12	2.12105640E+12
1.60000000E+01	2.30000000E+04	6.19426693E+12	1.95128937E+12
1.60000000E+01	2.40000000E+04	5.96828963E+12	1.75806427E+12
1.60000000E+01	2.50000000E+04	5.66047331E+12	1.54045318E+12
1.60000000E+01	2.60000000E+04	5.26401033E+12	1.29752012E+12
1.60000000E+01	2.70000000E+04	4.77185609E+12	1.02832127E+12
1.60000000E+01	2.80000000E+04	4.17672738E+12	7.31905152E+11
1.60000000E+01	2.90000000E+04	3.47110081E+12	4.07312884E+11
1.60000000E+01	3.00000000E+04	2.64721136E+12	5.35783609E+10
1.60000000E+01	3.10000000E+04	1.69705095E+12	-3.30271520E+11
1.60000000E+01	3.20000000E+04	6.12367092E+11	-7.45216650E+11
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1.60000000E+01	3.40000000E+04	-1.99481055E+12	-1.67234488E+12
1.60000000E+01	3.50000000E+04	-3.53504246E+12	-2.18651977E+12
1.60000000E+01	3.60000000E+04	-5.24527626E+12	-2.73577307E+12
1.60000000E+01	3.70000000E+04	-7.13500418E+12	-3.32111538E+12
1.60000000E+01	3.80000000E+04	-9.21396941E+12	-3.94356281E+12
1.60000000E+01	3.90000000E+04	-1.14921670E+13	-4.60413675E+12
1.60000000E+01	4.00000000E+04	-1.39798446E+13	-5.30386363E+12
1.70000000E+01	1.50000000E+04	3.76897993E+12	3.34706325E+12
1.70000000E+01	1.60000000E+04	4.00369073E+12	3.40806998E+12
1.70000000E+01	1.70000000E+04	4.21636904E+12	3.45465078E+12
1.70000000E+01	1.80000000E+04	4.40269160E+12	3.48591430E+12
1.70000000E+01	1.90000000E+04	4.55811918E+12	3.50095841E+12
1.70000000E+01	2.00000000E+04	4.67789431E+12	3.49887043E+12
1.70000000E+01	2.10000000E+04	4.75703904E+12	3.47872736E+12
1.70000000E+01	2.20000000E+04	4.79035284E+12	3.43959611E+12
1.70000000E+01	2.30000000E+04	4.77241049E+12	3.38053366E+12
1.70000000E+01	2.40000000E+04	4.69756011E+12	3.30058739E+12
1.70000000E+01	2.50000000E+04	4.55992117E+12	3.19879518E+12
1.70000000E+01	2.60000000E+04	4.35338267E+12	3.07418573E+12
1.70000000E+01	2.70000000E+04	4.07160133E+12	2.92577874E+12
1.70000000E+01	2.80000000E+04	3.70799982E+12	2.75258516E+12
1.70000000E+01	2.90000000E+04	3.25576517E+12	2.55360737E+12
1.70000000E+01	3.00000000E+04	2.70784712E+12	2.32783948E+12
1.70000000E+01	3.10000000E+04	2.05695660E+12	2.07426750E+12
1.70000000E+01	3.20000000E+04	1.29556435E+12	1.79186957E+12
1.70000000E+01	3.30000000E+04	4.15899459E+11	1.47961623E+12
1.70000000E+01	3.40000000E+04	-5.90051906E+11	1.13647064E+12
1.70000000E+01	3.50000000E+04	-1.73054773E+12	7.61388763E+11
1.70000000E+01	3.60000000E+04	-3.01409133E+12	3.53319663E+11
1.70000000E+01	3.70000000E+04	-4.44943244E+12	-8.87943060E+10

1.70000000E+01	3.80000000E+04	-6.04556823E+12	-5.66017248E+11
1.70000000E+01	3.90000000E+04	-7.81174427E+12	-1.07941950E+12
1.70000000E+01	4.00000000E+04	-9.75745539E+12	-1.63007738E+12
1.80000000E+01	1.50000000E+04	1.35232360E+12	3.44346158E+12
1.80000000E+01	1.60000000E+04	1.53961586E+12	3.58897809E+12
1.80000000E+01	1.70000000E+04	1.71607148E+12	3.72331087E+12
1.80000000E+01	1.80000000E+04	1.87803676E+12	3.84555206E+12
1.80000000E+01	1.90000000E+04	2.02164860E+12	3.95478164E+12
1.80000000E+01	2.00000000E+04	2.14283209E+12	4.05006765E+12
1.80000000E+01	2.10000000E+04	2.23729821E+12	4.13046641E+12
1.80000000E+01	2.20000000E+04	2.30054156E+12	4.19502281E+12
1.80000000E+01	2.30000000E+04	2.32783812E+12	4.24277048E+12
1.80000000E+01	2.40000000E+04	2.31424315E+12	4.27273207E+12
1.80000000E+01	2.50000000E+04	2.25458914E+12	4.28391946E+12
1.80000000E+01	2.60000000E+04	2.14348379E+12	4.27533405E+12
1.80000000E+01	2.70000000E+04	1.97530813E+12	4.24596695E+12
1.80000000E+01	2.80000000E+04	1.74421461E+12	4.19479923E+12
1.80000000E+01	2.90000000E+04	1.44412538E+12	4.12080221E+12
1.80000000E+01	3.00000000E+04	1.06873054E+12	4.02293764E+12
1.80000000E+01	3.10000000E+04	6.11486508E+11	3.90015798E+12
1.80000000E+01	3.20000000E+04	6.56144639E+10	3.75140664E+12
1.80000000E+01	3.30000000E+04	-5.75901159E+11	3.57561823E+12
1.80000000E+01	3.40000000E+04	-1.32031409E+12	3.37171879E+12
1.80000000E+01	3.50000000E+04	-2.17511760E+12	3.13862608E+12
1.80000000E+01	3.60000000E+04	-3.14804575E+12	2.87524976E+12
1.80000000E+01	3.70000000E+04	-4.24707460E+12	2.58049171E+12
1.80000000E+01	3.80000000E+04	-5.48042340E+12	2.25324622E+12
1.80000000E+01	3.90000000E+04	-6.85655560E+12	1.89240031E+12
1.80000000E+01	4.00000000E+04	-8.38417984E+12	1.49683389E+12
1.90000000E+01	1.50000000E+04	-1.09262502E+12	2.96491815E+12
1.90000000E+01	1.60000000E+04	-1.01680298E+12	3.18235697E+12
1.90000000E+01	1.70000000E+04	-9.43444002E+11	3.39226144E+12
1.90000000E+01	1.80000000E+04	-8.75526091E+11	3.59371806E+12
1.90000000E+01	1.90000000E+04	-8.16228893E+11	3.78579960E+12
1.90000000E+01	2.00000000E+04	-7.68936258E+11	3.96756534E+12
1.90000000E+01	2.10000000E+04	-7.37238713E+11	4.13806133E+12
1.90000000E+01	2.20000000E+04	-7.24935869E+11	4.29632065E+12
1.90000000E+01	2.30000000E+04	-7.36038760E+11	4.44136365E+12
1.90000000E+01	2.40000000E+04	-7.74772115E+11	4.57219818E+12
1.90000000E+01	2.50000000E+04	-8.45576551E+11	4.68781991E+12
1.90000000E+01	2.60000000E+04	-9.53110707E+11	4.78721255E+12
1.90000000E+01	2.70000000E+04	-1.10225330E+12	4.86934807E+12
1.90000000E+01	2.80000000E+04	-1.29810512E+12	4.93318705E+12
1.90000000E+01	2.90000000E+04	-1.54599093E+12	4.97767885E+12
1.90000000E+01	3.00000000E+04	-1.85146134E+12	5.00176193E+12
1.90000000E+01	3.10000000E+04	-2.22029455E+12	5.00436408E+12
1.90000000E+01	3.20000000E+04	-2.65849809E+12	4.98440270E+12
1.90000000E+01	3.30000000E+04	-3.17231040E+12	4.94078505E+12
1.90000000E+01	3.40000000E+04	-3.76820245E+12	4.87240853E+12
1.90000000E+01	3.50000000E+04	-4.45287919E+12	4.77816093E+12
1.90000000E+01	3.60000000E+04	-5.23328096E+12	4.65692070E+12
1.90000000E+01	3.70000000E+04	-6.11658486E+12	4.50755723E+12
1.90000000E+01	3.80000000E+04	-7.11020598E+12	4.32893109E+12
1.90000000E+01	3.90000000E+04	-8.22179865E+12	4.11989433E+12
1.90000000E+01	4.00000000E+04	-9.45925752E+12	3.87929072E+12
2.00000000E+01	1.50000000E+04	-3.17485970E+12	1.90127973E+12
2.00000000E+01	1.60000000E+04	-3.26398722E+12	2.17289626E+12
2.00000000E+01	1.70000000E+04	-3.35033331E+12	2.44096048E+12
2.00000000E+01	1.80000000E+04	-3.43620381E+12	2.70456604E+12
2.00000000E+01	1.90000000E+04	-3.52409720E+12	2.96279107E+12
2.00000000E+01	2.00000000E+04	-3.61670728E+12	3.21469855E+12
2.00000000E+01	2.10000000E+04	-3.71692579E+12	3.45933649E+12
2.00000000E+01	2.20000000E+04	-3.82784502E+12	3.69573828E+12
2.00000000E+01	2.30000000E+04	-3.95276026E+12	3.92292287E+12
2.00000000E+01	2.40000000E+04	-4.09517225E+12	4.13989514E+12
2.00000000E+01	2.50000000E+04	-4.25878955E+12	4.34564609E+12
2.00000000E+01	2.60000000E+04	-4.44753079E+12	4.53915318E+12
2.00000000E+01	2.70000000E+04	-4.66552689E+12	4.71938054E+12
2.00000000E+01	2.80000000E+04	-4.91712325E+12	4.88527932E+12
2.00000000E+01	2.90000000E+04	-5.20688176E+12	5.03578789E+12
2.00000000E+01	3.00000000E+04	-5.53958283E+12	5.16983220E+12
2.00000000E+01	3.10000000E+04	-5.92022732E+12	5.28632597E+12
2.00000000E+01	3.20000000E+04	-6.35403837E+12	5.38417105E+12
2.00000000E+01	3.30000000E+04	-6.84646321E+12	5.46225765E+12
2.00000000E+01	3.40000000E+04	-7.40317488E+12	5.51946465E+12
2.00000000E+01	3.50000000E+04	-8.03007382E+12	5.55465988E+12
2.00000000E+01	3.60000000E+04	-8.73328947E+12	5.56670038E+12
2.00000000E+01	3.70000000E+04	-9.51918175E+12	5.55443270E+12
2.00000000E+01	3.80000000E+04	-1.03943425E+13	5.51669319E+12
2.00000000E+01	3.90000000E+04	-1.13655968E+13	5.45230829E+12
2.00000000E+01	4.00000000E+04	-1.24400042E+13	5.36009481E+12

Example 2 Input

```
1  EXAMPLE  2 FULL DEPTH SANDWICH WING OPTIMIZATION RUN
 $OPTION  IPRINT=2,  IZCOR=0,  IOPT=2,   IPUNCH=0$
 $DIMNSHN NEL=100, NNOD=38, NTSEG=5, NSN=20, NEIG=5, NVEC=9, NMAT=2, NOV=7,
  NOC=7,  NF=2, NYS=7, NYC=4, NS=4, NXP=10 ,NFREE=0  $
 $WNGEOM  AR=2.5536,AREA=1.1316106E6,ANGLE1=50.5 , TAPER= .127065, DR=0.03 $
 $UNIT LUNIT=.0254 ,MUNIT=175.1268348,MNORM=.1,G=386.4 $
 $FLUTER  OMINIT=13.0,DELOM=.001, HINIT= -1524. , DELH=.3048,HMIN=-1524.,
     KFK=2, HCR=1524.,MACH=.6, KMAX=2., KMIN=0., KMED=1., REF=100.,NK=10 $
 $FLUTER OMINIT=16., DELOM=1.E-4, VINIT=30000., DELV=.1, VCR=30300.,
     A=12204., RHOA=5.14E- , GAMA=1.4, KFK=1$
 $MATTER                    RHO=4.14E-4, SIGMA1=1.25E5, SIGMA2=1.25E5,
     E1=1.64E7, E2=1.64E7, U21=.3, G12=.63075E7,  SIGMA12=7.217E4  $
 $MATTER E=1.64E7, U=.3, SIGMA1=1.25E5, SIGMA2=1.25E5, SIGMA12=7.217E4, IFL=1 $
     1        .03
     2        .15
     3        .28
     4        .48
     5        .64
     6        .88
     7       1.12
     8        .15        .12
     9        .28        .12
    10        .28        .25
    11        .38        .25
    12        .48        .25
    13        .64        .25
    14        .88        .25
    15       1.12        .25
    16        .38        .35
    17        .48        .35
    18        .48        .45
    19        .64        .45
    20        .88        .45
    21       1.12        .45
    22        .64        .61
    23        .77        .61
    24        .88        .61
    25       1.12        .61
    26        .77        .74
    27        .88        .74
    28        .96        .74
    29       1.12        .74
    30        .88        .85
    31        .96        .85
    32       1.03        .85
    33       1.12        .85
    34        .96        .93
    35       1.03        .93
    36       1.12        .93
    37       1.03       1.00
1   38       1.12       1.00                        1031.132    853.
     1    2    1    2    8       .02                1 16.3
     2         2    3    9
     3         2    9    8
     4         8    9   10
     5         3    4    9
     6         9    4   11
     7         9   11   10
     8         4   12   11
     9        10   11   16
    10        11   12   16
    11        12   17   16
    12        16   17   18
```

13		4	5	13			
14		4	13	12			
15		12	15	17			
16		13	19	17			
17		17	19	18			
18		18	19	22			
19		5	5	14			
20		5	14	13			
21		13	14	2			
22		13	2	19			
23		19	2	23			
24		20	24	23			
25		19	23	22			
26		22	23	26			
27		23	27	26			
28		23	24	27			
29		26	27	30			
30		6	7	15			
31		6	15	14			
32		14	15	21			
33		14	21	20			
34		20	21	25			
35		20	25	24			
36		24	26	27			
37		24	25	28			
38		25	29	28			
39		27	31	30			
40		27	28	31			
41		28	32	31			
42		28	29	32			
43		29	33	32			
44		30	31	34			
45		31	35	34			
46		31	32	35			
47		32	36	35			
48		32	33	36			
49		34	35	37			
50		35	38	37			
51		35	36	38			
52	4	2	8		9.0	2	
53	4	8	9				40.
54		9	3				
55		9	1				
56		10	11				
57		11	12				
58		12	4				
59		11	16				
60		16	17				
61		17	12				
62		17	18				
63		18	19				
64		19	13				
65		13	12				
66		13	5				
67		19	22				
68		22	23				
69		19	2				
70		13	14				
71		23	24				
72		23	26				
73		26	27				
74		6	14				
75		14	2				
76		20	24				
77		24	27				
78		27	3				

```
     79          30    31
     80          27    28
     81          24    25
     82          20    21
     83          14    15
     84           7    15
     85          15    21
     86          21    25
     87          25    29
     88          29    28
     89          28    31
     90          31    32
     91          32    33
     92          33    29
     93          33    36
     94          36    35
     95          35    32
     96          31    34
     97          34    35
     98          35    37
     99          37    36
1   100          38    36
      1 000       2 000      3 000       4 000       5 000       6 000       7 000
      1     4    18          .02         .02         .02
      4     6    14    12    .02         .02         .02                     1     1     1
     12    14    20    18    .02         .02         .02         .02         2     5     5     2
     18    20    30          .02         .02         .02         .02         3     3     3     3
1     6     7    33    30    .02         .02         .02                     1     4     1
  $TETA  ITHETA=0$                                             .02         6     1     1     5
  CMASS          18    18                 7
1VMASS            1    51     4.[illegible]E-5
1PLOAD            1    51    0.5
   0            .25          .45          .61         .74         .85         .9[illegible]
      7     6     4     4     4     4     3
      2     4     6     7
      1     2     3     4     5     6     7
     10    11    12    13    14    15
     18    19    20    21
     22    23    24    25
     26    27    28    29
     30    31    32    33
     34    35    36
$CONSTR STRESS=.T., GAGE=.T., FLUTTER=.T.$
$OPTIMUM C(1)= 6*.08, R=.250,RDC=30., C(7)=.1$
      TWO FLUTTER M=.6
$NAM1 MACH=.60, NK=10, KMAX=2.0, KMIN=0., KMED=1.$
```

Example 2 Output

```
EXAMPLE    2 FULL DEPTH SANDWICH WING OPTIMIZATION RUN

INPUT OPTIONS

    IPRINT = 2       1 - NORMAL PRINTOUT, 2 - EXTENDED PRINTOUT
    IZCOR = 0.       0 - BICONVEX SYMMETRIC, -1 - INPUT Z COORDINATES
    IOPT = 2         1 - A SINGLE ANALYSIS, 2 - OPTIMIZATION
    IPUNCH = 0       1 - PUNCH A NASTRAN DECK, 0 - NO PUNCH

$DIMNSHN
NEL     =  100,
NNOD    =  38,
NTSEG   =  5,
NSW     =  20,
NEIG    =  5,
NVEC    =  9,
NMAT    =  2,
NDV     =  7,
NOC     =  7,
NF      =  2,
NYS     =  7,
NYC     =  4,
NS      =  4,
NXP     =  10,
NFRCE   =  0,
NL      =  0,
NT      =  0,
$END
```

```
$ADRESS
NODES   =  1,
COON    =  401,
IA      =  515,
ITYPE   =  1256,
MAT     =  1356,
ELTHK   =  1456,
LI      =  1556,
NRR     =  1594,
A       =  1708,
RHOA    =  1710,
GAMA    =  1712,
V       =  1716,
VI      =  1720,
DV      =  1724,
VF      =  1728,
VCR     =  1732,
ACTIV   =  1734,
KF      =  1738,
YY      =  1740,
NY      =  1747,
IY      =  1754,
KC      =  1824,
XI      =  1831,
THETA   =  1901,
Q       =  2001,
SIGMA   =  2019,
THTSEG  =  2025,
IGAIN   =  2030,
SG      =  2032,
NK      =  2034,
MACH    =  2036,
KM      =  2038,
NTAPE   =  2044,
REF     =  2046,
TUL     =  2048,
XPL     =  2052,
YPL     =  2056,
BPL     =  2060,
RHOE    =  2064,
```

```
NNN      =  2066,
NSE      =  2166,
NNS      =  2266,
MASS     =  2271,
VECLOD   =  2309,
VECMAS   =  2423,
VECNSM   =  2461,
VSRM     =  2499,
CSAV     =  2537,
DC       =  2544,
DIRCOS   =  2551,
NODSEG   =  2558,
TSEG     =  2578,
NDSIGN   =  2598,
C        =  2618,
NELDS    =  2626,
AD       =  2726,
VFREE    =  2733,
X        =  2733,
Z        =  2743,
DTHICK   =  2753,
INIT     =  3153,
IFIN     =  3161,
ISTORE   =  3169,
NDC      =  3177,
INC      =  3184,
DHDX     =  3205,
TNOD     =  3275,
FK       =  3465,
$END

WING DESCRIPTION

     ASPECT RATIO............AR =  2.55380000E+00
     SURFACE AREA..........AREA =  1.13161600E+06
     L.E. SWEEP ANGLE...ANGLE1 =  5.05000000E+01 DEGREES
     SEMISPAN...............SS =  8.49988374E+02
     SEMI-ROOT CHORD......BREF =  5.90618621E+02
     TAPER RATIO.........TAPER =  1.27065000E-01
     DEPTH RATIO.............DR =  3.00000000E-02
```

```
$UNIT

G        =  0.3864E+03,

LUNIT    =  0.254E-01,

MUNIT    =  0.1751268348E+03,

MNORM    =  0.1E+00,

$END


FLUTTER CONDITION  1


SUBSONIC KERNEL FUNCTION AERODYNAMICS

     MACH NUMBER..................MACH  =  6.00000000E-01
     AERO DATA TAPE NUMBER.......NTAPE  =  17
     NUMBER OF K VALUES.............NK  =  10
     MAXIMUM K....................KMAX  =  2.00000000E+00
     MEDIAN K.....................KMED  =  1.00000000E+00
     MINIMUM K....................KMIN  =  0.
     GAIN FACTOR.................IGAIN  =  10
     STRUCTURAL DAMPING.............SG  =  2.00000000E-02
     REFERENCE FREQUENCY...........REF  =  1.00000000E+02


     OMEGA INITIAL..............OMINIT  =  1.30000000E+01 RADIANS/SEC.
     OMEGA INCREMENT.............DELOM  =  1.00000000E-03 RADIANS/SEC.
     H INITIAL...................HINIT  = -1.52400000E+03 METERS
     H INCREMENT..................DELH  =  3.04800000E-01 METERS
     H LOWER BOUND................HFIN  = -1.52400000E+04 METERS
     H CRITICAL....................HCR  =  1.52400000E+03 METERS


FLUTTER CONDITION  2


SUPERSONIC PISTON THEORY AERODYNAMICS

     SPEED OF SOUND...................A  =  1.22040000E+04
     AIR MASS DENSITY..............RHOA  =  5.14000000E-08
     CP/CV.........................GAMA  =  1.40000000E+00


     OMEGA INITIAL..............OMINIT  =  1.60000000E+01 RADIANS/SEC.
     OMEGA INCREMENT.............DELOM  =  1.00000000E-04 RADIANS/SEC.
     V INITIAL...................VINIT  =  3.00000000E+04
     V INCREMENT..................DELV  =  1.00000000E-01
     V CRITICAL....................VCR  =  3.03000000E+04
```

MATERIAL PROPERTIES

	Q11	Q21	Q22	Q31	Q32	Q33
1	1.8022E+07	5.4066E+06	1.8022E+07	0.	0.	1.2615E+07
2	1.8022E+07	5.4066E+06	1.8022E+07	0.	0.	1.2615E+07

SIGMA1	SIGMA2	SIGMA12	RHO
1.2500E+05	1.2500E+05	7.2170E+04	4.1400E-04
1.2500E+05	1.2500E+05	7.2170E+04	0.

SEGMENT DATA

SEGMENT 1 IS DEFINED BY NODES 1 4 18 -0 MATERIAL ORIENTATION I DEGREES

NODE	THICKNESS
1	2.00000000E-02
2	2.00000000E-02
3	2.00000000E-02
4	2.00000000E-02
8	2.00000000E-02
9	2.00000000E-02
10	2.00000000E-02
11	2.00000000E-02
12	2.00000000E-02
16	2.00000000E-02
17	2.00000000E-02
18	2.00000000E-02

SEGMENT 2 IS DEFINED BY NODES 4 6 14 12 MATERIAL ORIENTATION I DEGREES

NODE	THICKNESS
4	2.00000000E-02
5	2.00000000E-02
6	2.00000000E-02
12	2.00000000E-02
13	2.00000000E-02
14	2.00000000E-02

SEGMENT 3 IS DEFINED BY NODES 12 14 20 18 MATERIAL ORIENTATION I DEGREES

NODE	THICKNESS
12	2.00000000E-02
13	2.00000000E-02
14	2.00000000E-02
17	2.00000000E-02
18	2.00000000E-02
19	2.00000000E-02
20	2.00000000E-02

SEGMENT 4 IS DEFINED BY NODES 18 20 30 -0 MATERIAL ORIENTATION I DEGREES

NODE	THICKNESS
18	2.00000000E-02
19	2.00000000E-02
20	2.00000000E-02
22	2.00000000E-02
23	2.00000000E-02
24	2.00000000E-02
26	2.00000000E-02
27	2.00000000E-02
30	2.00000000E-02

SEGMENT 5 IS DEFINED BY NODES 6 7 33 30 MATERIAL ORIENTATION I DEGREES

NODE	THICKNESS
6	2.00000000E-02
7	2.00000000E-02
14	2.00000000E-02
15	2.00000000E-02
20	2.00000000E-02
21	2.00000000E-02
24	2.00000000E-02
25	2.00000000E-02
27	2.00000000E-02
28	2.00000000E-02
29	2.00000000E-02
30	2.00000000E-02
31	2.00000000E-02
32	2.00000000E-02
33	2.00000000E-02

NODAL DATA

NODE	NRK	X	Y	Z	MASS
1	000	3.0933960E+01	0.	1.8074321E+00	3.2936376E-01
2	000	1.5466980E+02	0.	8.0650512E+00	2.1126593E+00
3	000	2.8871696E+02	0.	1.3088941E+01	3.1127734E+00
4	000	4.9494336E+02	0.	1.7253601E+01	1.5473495E+01
5	000	6.5992448E+02	0.	1.7474579E+01	1.5921925E+01
6	000	9.0739616E+02	0.	1.2621462E+01	1.1877586E+01
7	000	1.1548678E+03	0.	1.5468446E+00	1.7358299E+00
8	111	1.5466980E+02	1.0200000E+02	1.8017417E+00	1.2438982E+00
9	111	2.8871696E+02	1.0200000E+02	8.3545352E+00	7.1537762E+00
10	111	2.8871696E+02	2.1250000E+02	1.7938571E+00	1.0113926E+00
11	111	3.9183016E+02	2.1250000E+02	6.8753323E+00	5.3869459E+00
12	111	4.9494336E+02	2.1250000E+02	1.0575160E+01	7.3075743E+00
13	111	6.5992448E+02	2.1250000E+02	1.3621056E+01	2.3942519E+01
14	111	9.0739616E+02	2.1250000E+02	1.1557989E+01	2.2661897E+01
15	111	1.1548678E+03	2.1250000E+02	1.5366315E+00	5.7389148E+00
16	111	3.9183016E+02	2.9750000E+02	1.7860393E+00	1.1123753E+00
17	111	4.9494336E+02	2.9750000E+02	6.7285769E+00	4.2009407E+00
18	111	4.9494336E+02	3.8250000E+02	1.7759744E+00	1.3099093E+00
19	111	6.5992448E+02	3.8250000E+02	8.5439254E+00	9.7727011E+00
20	111	9.0739616E+02	3.8250000E+02	1.0156974E+01	1.6207419E+01
21	111	1.1548678E+03	3.8250000E+02	1.5233688E+00	4.2249772E+00
22	111	6.5992448E+02	5.1850000E+02	1.7520545E+00	1.6102269E+00
23	111	7.9397164E+02	5.1850000E+02	6.9415372E+00	5.4804027E+00
24	111	9.0739616E+02	5.1850000E+02	8.2828984E+00	5.1935231E+00
25	111	1.1548678E+03	5.1850000E+02	1.5057877E+00	3.6226802E+00
26	111	7.9397164E+02	6.2900000E+02	1.7187243E+00	9.6013321E-01
27	111	9.0739616E+02	6.2900000E+02	5.6714982E+00	2.4248677E+00
28	111	9.8988672E+02	6.2900000E+02	6.2274639E+00	3.2841390E+00
29	111	1.1548678E+03	6.2900000E+02	1.4814275E+00	9.3831649E-01
30	111	9.0739616E+02	7.2250000E+02	1.6676223E+00	5.2399438E-01
31	111	9.8988672E+02	7.2250000E+02	4.2725739E+00	1.1907117E+00
32	111	1.0620660E+03	7.2250000E+02	4.3539431E+00	1.3892127E+00
33	111	1.1548678E+03	7.2250000E+02	1.4442105E+00	2.5936863E-01
34	111	9.8988672E+02	7.9050000E+02	1.5976985E+00	2.7430620E-01
35	111	1.0620660E+03	7.9050000E+02	3.3165591E+00	7.0258575E-01
36	111	1.1548678E+03	7.9050000E+02	1.3933901E+00	3.2031959E-01
37	111	1.0620660E+03	8.5000000E+02	1.4734612E+00	1.5204059E-01
38	111	1.1548678E+03	8.5000000E+02	1.3032014E+00	1.6417938E-01

LOAD DATA

NODE	XLOAD	YLOAD	ZLOAD
1	0.	0.	1.0517546E+03
2	0.	0.	3.3305564E+03
3	0.	0.	2.8923253E+03
4	0.	0.	1.2197432E+04
5	0.	0.	1.1686163E+04
6	0.	0.	1.3146933E+04
7	0.	0.	4.3823110E+03
8	0.	0.	3.4255064E+03
9	0.	0.	8.9910414E+03
10	0.	0.	2.9142368E+03
11	0.	0.	7.0116976E+03
12	0.	0.	7.3768902E+03
13	0.	0.	2.0742939E+04
14	0.	0.	2.3664479E+04
15	0.	0.	1.2270471E+04
16	0.	0.	2.9215407E+03
17	0.	0.	6.1352354E+03
18	0.	0.	3.7687875E+03
19	0.	0.	1.3205364E+04
20	0.	0.	2.0217061E+04
21	0.	0.	9.8163766E+03
22	0.	0.	4.6233381E+03
23	0.	0.	8.9326106E+03
24	0.	0.	8.1730100E+03
25	0.	0.	9.4073609E+03
26	0.	0.	3.1625678E+03
27	0.	0.	5.0177461E+03
28	0.	0.	7.0482169E+03
29	0.	0.	3.5277604E+03
30	0.	0.	1.9939515E+03
31	0.	0.	3.1333524E+03
32	0.	0.	4.0317261E+03
33	0.	0.	1.2489586E+03
34	0.	0.	1.2343509E+03
35	0.	0.	2.6220827E+03
36	0.	0.	1.5118973E+03
37	0.	0.	8.1803139E+02
38	0.	0.	9.2028531E+02

TOTAL MASS IS 1.903299E+02

ELEMENT DATA

ELEMENT	NODES				SEGMENT	TYPE	THICKNESS	MATERIAL	THETA
1	1	2	8	-0	1	2	2.0000000E-02	1	1.6300000E+01
2	2	3	9	-0	1	2	2.0000000E-02	1	-0.
3	2	9	8	-0	1	2	2.0000000E-02	1	-0.
4	8	9	10	-0	1	2	2.0000000E-02	1	-0.
5	3	4	9	-0	1	2	2.0000000E-02	1	-0.
6	9	4	11	-0	1	2	2.0000000E-02	1	-0.
7	9	11	10	-0	1	2	2.0000000E-02	1	-0.
8	4	12	11	-0	1	2	2.0000000E-02	1	-0.
9	10	11	16	-0	1	2	2.0000000E-02	1	-0.
10	11	12	16	-0	1	2	2.0000000E-02	1	-0.
11	12	17	16	-0	1	2	2.0000000E-02	1	-0.
12	16	17	18	-0	1	2	2.0000000E-02	1	-0.
13	4	5	13	-0	2	2	2.0000000E-02	1	-0.
14	4	13	12	-0	2	2	2.0000000E-02	1	-0.
15	12	13	17	-0	3	2	2.0000000E-02	1	-0.
16	13	19	17	-0	3	2	2.0000000E-02	1	-0.
17	17	19	18	-0	3	2	2.0000000E-02	1	-0.
18	18	19	22	-0	4	2	2.0000000E-02	1	-0.
19	5	6	14	-0	2	2	2.0000000E-02	1	-0.
20	5	14	13	-0	2	2	2.0000000E-02	1	-0.
21	13	14	20	-0	3	2	2.0000000E-02	1	-0.
22	13	20	19	-0	3	2	2.0000000E-02	1	-0.
23	19	20	23	-0	4	2	2.0000000E-02	1	-0.
24	20	24	23	-0	4	2	2.0000000E-02	1	-0.
25	19	23	22	-0	4	2	2.0000000E-02	1	-0.
26	22	23	26	-0	4	2	2.0000000E-02	1	-0.
27	23	27	26	-0	4	2	2.0000000E-02	1	-0.
28	23	24	27	-0	4	2	2.0000000E-02	1	-0.
29	26	27	30	-0	4	2	2.0000000E-02	1	-0.
30	6	7	15	-0	5	2	2.0000000E-02	1	-0.
31	6	15	14	-0	5	2	2.0000000E-02	1	-0.
32	14	15	21	-0	5	2	2.0000000E-02	1	-0.
33	14	21	20	-0	5	2	2.0000000E-02	1	-0.
34	20	21	25	-0	5	2	2.0000000E-02	1	-0.
35	20	25	24	-0	5	2	2.0000000E-02	1	-0.
36	24	28	27	-0	5	2	2.0000000E-02	1	-0.
37	24	25	28	-0	5	2	2.0000000E-02	1	-0.
38	25	29	28	-0	5	2	2.0000000E-02	1	-0.
39	27	31	30	-0	5	2	2.0000000E-02	1	-0.
40	27	28	31	-0	5	2	2.0000000E-02	1	-0.
41	28	32	31	-0	5	2	2.0000000E-02	1	-0.
42	28	29	32	-0	5	2	2.0000000E-02	1	-0.
43	29	33	32	-0	5	2	2.0000000E-02	1	-0.
44	30	31	34	-0	0	2	2.0000000E-02	1	-0.
45	31	35	34	-0	0	2	2.0000000E-02	1	-0.
46	31	32	35	-0	0	2	2.0000000E-02	1	-0.
47	32	36	35	-0	0	2	2.0000000E-02	1	-0.
48	32	33	36	-0	0	2	2.0000000E-02	1	-0.
49	34	35	37	-0	0	2	2.0000000E-02	1	-0.
50	35	38	37	-0	0	2	2.0000000E-02	1	-0.
51	35	36	38	-0	0	2	2.0000000E-02	1	-0.
52	2	8	-0	-0	0	4	9.8000000E+00	2	-0.
53	8	9	-0	-0	0	4	9.8000000E+00	2	4.0000000E+01
54	9	3	-0	-0	0	4	9.8000000E+00	2	-0.
55	9	10	-0	-0	0	4	9.8000000E+00	2	-0.
56	10	11	-0	-0	0	4	9.8000000E+00	2	-0.
57	11	12	-0	-0	0	4	9.8000000E+00	2	-0.
58	12	4	-0	-0	0	4	9.8000000E+00	2	-0.
59	11	16	-0	-0	0	4	9.8000000E+00	2	-0.
60	16	17	-0	-0	0	4	9.8000000E+00	2	-0.
61	17	12	-0	-0	0	4	9.8000000E+00	2	-0.
62	17	18	-0	-0	0	4	9.8000000E+00	2	-0.
63	18	19	-0	-0	0	4	9.8000000E+00	2	-0.
64	19	13	-0	-0	0	4	9.8000000E+00	2	-0.
65	13	12	-0	-0	0	4	9.8000000E+00	2	-0.
66	13	5	-0	-0	0	4	9.8000000E+00	2	-0.
67	19	22	-0	-0	0	4	9.8000000E+00	2	-0.
68	22	23	-0	-0	0	4	9.8000000E+00	2	-0.
69	19	20	-0	-0	0	4	9.8000000E+00	2	-0.
70	13	14	-0	-0	0	4	9.8000000E+00	2	-0.
71	23	24	-0	-0	0	4	9.8000000E+00	2	-0.
72	23	26	-0	-0	0	4	9.8000000E+00	2	-0.
73	26	27	-0	-0	0	4	9.8000000E+00	2	-0.
74	6	14	-0	-0	0	4	9.8000000E+00	2	-0.
75	14	20	-0	-0	0	4	9.8000000E+00	2	-0.

76	20	24	-0	-0	0	4	9.8000000E+00	2	-0.
77	24	27	-0	-0	0	4	9.8000000E+00	2	-0.
78	27	30	-0	-0	0	4	9.8000000E+00	2	-0.
79	30	31	-0	-0	0	4	9.8000000E+00	2	-0.
80	27	28	-0	-0	0	4	9.8000000E+00	2	-0.
81	24	25	-0	-0	0	4	9.8000000E+00	2	-0.
82	20	21	-0	-0	0	4	9.8000000E+00	2	-0.
83	14	15	-0	-0	0	4	9.8000000E+00	2	-0.
84	7	15	-0	-0	0	4	9.8000000E+00	2	-0.
85	15	21	-0	-0	0	4	9.8000000E+00	2	-0.
86	21	25	-0	-0	0	4	9.8000000E+00	2	-0.
87	25	29	-0	-0	0	4	9.8000000E+00	2	-0.
88	29	28	-0	-0	0	4	9.8000000E+00	2	-0.
89	28	31	-0	-0	0	4	9.8000000E+00	2	-0.
90	31	32	-0	-0	0	4	9.8000000E+00	2	-0.
91	32	33	-0	-0	0	4	9.8000000E+00	2	-0.
92	33	29	-0	-0	0	4	9.8000000E+00	2	-0.
93	33	36	-0	-0	0	4	9.8000000E+00	2	-0.
94	36	35	-0	-0	0	4	9.8000000E+00	2	-0.
95	35	32	-0	-0	0	4	9.8000000E+00	2	-0.
96	31	34	-0	-0	0	4	9.8000000E+00	2	-0.
97	34	35	-0	-0	0	4	9.8000000E+00	2	-0.
98	35	37	-0	-0	0	4	9.8000000E+00	2	-0.
99	37	38	-0	-0	0	4	9.8000000E+00	2	-0.
100	38	36	-0	-0	0	4	9.8000000E+00	2	-0.

```
AERO MESH DATA

    STATION                                  NODES


    0.0000            1    2    3    4    5    6    7

     .2500           10   11   12   13   14   15

     .4500           18   19   20   21

     .6100           22   23   24   25

     .7400           26   27   28   29

     .8500           30   31   32   33

     .9500           34   35   36

COLLOCATION STATIONS      2    4    6    7

DESIGN CONSTRAINTS CONSIDERED
    FLUTTER - T
     STRESS - T
    MINGAGE - T

INPUT DATA FOR SEARCH ROUTINE

    NUMBER OF DESIGN VARIABLES....NC =  7
                                   R =  2.50000000E-01
    R REDUCTION FACTOR...........RDC =  3.00000000E+01

TOL( 1)= 1.00000E+00
TOL( 2)= 1.00000E+00
TOL( 3)= 3.00000E+01
TOL( 4)= 1.00000E+00

 NO.        POINTS  OR  ELEMENTS             VALUE             MASS DERIVATIVE


  1          SEGMENT  1 POINT 1          8.00000000E-02         9.31026354E+01
             SEGMENT  1 POINT 2
             SEGMENT  1 POINT 3
             SEGMENT  4 POINT 1
             SEGMENT  4 POINT 3
             SEGMENT  5 POINT 2
             SEGMENT  5 POINT 3

  2          SEGMENT  2 POINT 1          8.00000000E-02         1.81427675E+01
             SEGMENT  2 POINT 4

  3          SEGMENT  3 POINT 1          8.00000000E-02         2.90284281E+01
             SEGMENT  3 POINT 2
             SEGMENT  3 POINT 3
             SEGMENT  3 POINT 4

  4          SEGMENT  4 POINT 2          8.00000000E-02         9.67614269E+00

  5          SEGMENT  2 POINT 2          8.00000000E-02         1.81427675E+01
             SEGMENT  2 POINT 3

  6          SEGMENT  5 POINT 1          8.00000000E-02         3.70112458E+01
             SEGMENT  5 POINT 4

  7          MASS AT NODE 18             1.00000000E-01         1.00000000E+01

TOTAL NUMBER OF D.O.F. = 93
THIS PROGRAM REQUIRES 021457(OCTAL) OF BLANK COMMON
```

```
$NAM1

MACH   =  0.6E+00,

NK     =  10,

KMAX   =  0.2E+01,

KMED   =  0.1E+01,

KMIN   =  0.0,

NM     =  2879489011175006132,

SYM    =  0,

ZETA   =  0.1E+00,

NG     =  5,

XG     =  0.14887433898163E+00,  0.43339539412925E+00,  0.67940956829903E+00,
          0.86506336668899E+00,  0.97390652851717E+00, 1, 1, 1, 1, 1, 1, 1, 1,
         1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,

WG     =  0.29552422471475E+00,  0.26926671931E+00,  0.21908636251598E+00,
          0.14945134915058E+00,  0.66671344308688E-01, 1, 1, 1, 1, 1, 1, 1, 1,
         1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,

$END


MISCELLANEOUS GEOMETRIC PARAMETERS

ROOT SEMICHORD, BREF = 590.618620635

SEMISPAN/BREF = 1.43914929850

REFERENCE VOLUME = 354962180.333

PANEL AREA = 565808.000000

PANEL ASPECT RATIO = 1.27690000000

MEAN AERODYNAMIC CHORD = 798.772525106

MEAN CHORD = 665.665575666
```

```
$ADRESS
NODES   =  1,
CODN    =  401,
IA      =  515,
ITYPE   =  1256,
MAT     =  1356,
ELTHK   =  1456,
LI      =  1556,
NRR     =  1594,
RA      =  1708,
RHOA    =  1710,
GAMA    =  1712,
V       =  1716,
VI      =  1720,
DV      =  1724,
VF      =  1728,
VCR     =  1732,
ACTIV   =  1734,
KF      =  1738,
YY      =  1740,
NY      =  1747,
IY      =  1754,
KC      =  1824,
XI      =  1831,
THETA   =  1901,
Q       =  2001,
SIGMA   =  2019,
THTSEG  =  2025,
IGAIN   =  2030,
SG      =  2032,
NK      =  2034,
MACH    =  2036,
KM      =  2038,
NTAPE   =  2044,
REF     =  2046,
TOL     =  2048,
XPL     =  2052,
YPL     =  2056,
BPL     =  2060,
RHOE    =  2064,
```

```
NNN     =  2066,
NSE     =  2166,
NNS     =  2266,
MASS    =  2271,
VECLOD  =  2309,
VECMAS  =  2423,
VECNSM  =  2461,
VSRM    =  2499,
CSAV    =  2537,
DC      =  2544,
DIRCOS  =  2551,
NODSEG  =  2558,
TSEG    =  2578,
NOSIGN  =  2598,
C       =  2618,
NELDS   =  2626,
AD      =  2726,
VFREE   =  2733,
UTHICK  =  2753,
INIT    =  3153,
IFIN    =  3161,
ISTORE  =  3169,
NDC     =  3177,
INC     =  3184,
DHDX    =  3205,
TNOD    =  3275,
FK      =  3465,
VK      =  9007,
VDK     =  9017,
D       =  9027,
H       =  9034,
HH      =  9041,
EQSTR   =  9090,
VV      =  9190,
DE      =  9532,
STR     =  9541,
```

```
W       =  9841,
DISP    =  9955,
UE      =  9541,
BE      =  10567,
BB      =  10648,
T       =  10693,
ISET    =  10731,
AAC     =  9541,
VMAT    =  9591,
OMMAT   =  9616,
VOMAT   =  9641,
VZMAT   =  9666,
GFR     =  9591,
GFI     =  9841,
FREQ    =  10091,
GM      =  10096,
DZ      =  9591,
ZH      =  9607,
FQ      =  9623,
F       =  9639,
X       =  9688,
HF      =  9698,
RGF     =  9708,
TT      =  9728,
EB      =  9897,
FB      =  9918,
MATAER  =  9691,
BDZ     =  10121,
BZH     =  10201,
BFQ     =  10281,
YAR     =  10361,
TR      =  10377,
TI      =  10402,
BX      =  10427,
BY      =  10507,
GFRD    =  10121,
GFID    =  10371,
AMAT    =  10666,
AK      =  11002,
AI      =  10922,
```

```
RMAT    =  11082,
V3      =  11338,
VPLUS   =  11342,
G11     =  11346,
GG1     =  11350,
G1      =  11354,
VA      =  11394,
V1      =  11434,
VP      =  11438,
VPP     =  11442,
G1D     =  11446,
G1P     =  11450,
G1PP    =  11454,
EOSS    =  11458,
VDR     =  12258,
VS      =  12272,
GP1     =  12274,
MARK    =  12278,
$END

THIS PROGRAM REQUIRES 027766(OCTAL) OF BLANK COMMON
```

DISPLACEMENT FIELD

NODE	U	V	W
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	0.	0.
5	0.	0.	0.
6	0.	0.	0.
7	0.	0.	0.
8	9.02201090E-03	-4.99859755E-04	5.21390589E-03
9	-2.50228409E-02	-4.50695418E-02	2.15568331E-01
10	2.99366556E-03	-1.48312689E-02	8.67557447E-01
11	-5.81191646E-02	-1.32989099E-01	1.52225528E+00
12	-9.73373774E-02	-3.18970157E-01	2.43937879E+00
13	-1.91367527E-01	-6.44104209E-01	4.40678178E+00
14	-2.10720474E-01	-9.46939869E-01	8.35014730E+00
15	1.20113494E-02	-1.75732722E-01	1.21108374E+01
16	-2.75570751E-02	-4.70864836E-02	3.28952147E+00
17	-1.42001139E-01	-2.71841164E-01	5.34255438E+00
18	-2.66900859E-02	-9.14851105E-02	8.97492875E+00
19	-3.40490835E-01	-7.16075752E-01	1.48453968E+01
20	-4.69734572E-01	-1.25173292E+00	2.55718694E+01
21	-2.74782101E-02	-2.56091349E-01	3.61080024E+01
22	-1.09872450E-01	-2.13532687E-01	2.71277410E+01
23	-4.74050471E-01	-9.05374169E-01	3.61336169E+01
24	-5.95274544E-01	-1.25926364E+00	4.40986064E+01
25	-8.19802209E-02	-3.03343653E-01	6.12251750E+01
26	-1.50807980E-01	-2.72924754E-01	5.11701394E+01
27	-5.37240667E-01	-9.67081597E-01	6.17318622E+01
28	-5.73924222E-01	-1.10138894E+00	6.94380785E+01
29	-1.19679179E-01	-3.19885148E-01	8.42824603E+01
30	-1.64570196E-01	-3.01681042E-01	7.78964843E+01
31	-4.60622829E-01	-8.23182558E-01	8.65785801E+01
32	-4.62305844E-01	-8.57986513E-01	9.43028238E+01
33	-1.55234703E-01	-3.02964351E-01	1.04187695E+02
34	-1.81083652E-01	-3.36196654E-01	1.00008849E+02
35	-4.13414393E-01	-7.70502759E-01	1.08740603E+02
36	-1.72302803E-01	-3.68587523E-01	1.20281468E+02
37	-2.13013924E-01	-3.63467834E-01	1.22826746E+02
38	-1.84049332E-01	-3.48211905E-01	1.36097761E+02

STRESS FIELD

ELEMENT	THICKNESS	SIGMA X	SIGMA Y	SIGMA XY	STRESS RATIO
1	8.00000000E-02	-2.58938878E+02	4.40003303E+02	-4.55958564E+02	.008
2	8.00000000E-02	2.91460132E+03	9.71533775E+03	1.04590634E+03	.071
3	8.00000000E-02	4.51253609E+03	-1.58076018E+02	-4.58620766E+02	.037
4	8.00000000E-02	3.59831051E+03	2.32699741E+03	-7.25033867E+02	.027
5	8.00000000E-02	2.91406262E+03	9.71354207E+03	1.27653257E+03	.071
6	8.00000000E-02	5.40794873E+03	1.66291337E+04	-4.19263199E+03	.131
7	8.00000000E-02	1.02542758E+04	-1.85860542E+03	-1.70558117E+03	.093
8	8.00000000E-02	3.38638431E+04	1.12009008E+04	-1.34420656E+04	.303
9	8.00000000E-02	6.29417700E+03	5.72303074E+03	9.02706108E+02	.050
10	8.00000000E-02	2.37772792E+03	4.58436836E+03	7.74498040E+03	.112
11	8.00000000E-02	1.86885862E+04	8.22102853E+03	-1.24196778E+04	.216
12	8.00000000E-02	4.77870397E+03	7.44694132E+03	-4.04475465E+02	.053
13	8.00000000E-02	1.84150932E+04	6.13836441E+04	5.50412853E+03	.443
14	8.00000000E-02	4.40999338E+04	7.70395062E+03	5.17003909E+03	.334
15	8.00000000E-02	1.16605021E+04	1.97533218E+04	1.51568459E+04	.251
16	8.00000000E-02	4.10102398E+04	1.34166146E+04	-1.58206879E+04	.363
17	8.00000000E-02	2.39100244E+04	-4.81594809E+03	9.67418353E+03	.252
18	8.00000000E-02	1.23558163E+04	1.70450084E+04	1.03302438E+03	.123
19	8.00000000E-02	2.51544575E+04	8.38481918E+04	1.11129793E+04	.616
20	8.00000000E-02	5.54414006E+04	2.92917728E+04	2.23839328E+04	.494
21	8.00000000E-02	1.80081116E+04	4.84908360E+04	2.34821779E+04	.470
22	8.00000000E-02	4.78466055E+04	1.06237965E+04	2.07644460E+04	.452
23	8.00000000E-02	1.15134326E+04	2.52732074E+04	1.68959756E+04	.292
24	8.00000000E-02	3.61132368E+04	1.47507512E+04	-2.14445983E+04	.389
25	8.00000000E-02	3.19553885E+04	-1.00490253E+04	4.08406307E+03	.309
26	8.00000000E-02	5.90608033E+03	1.33647242E+04	9.05011602E+02	.094
27	8.00000000E-02	2.81109535E+04	-7.65760777E+03	3.89707172E+03	.266
28	8.00000000E-02	1.03877623E+04	2.16002210E+04	1.49269673E+04	.255
29	8.00000000E-02	4.46207128E+03	6.03387143E+03	6.12584890E+02	.044
30	8.00000000E-02	4.48591166E+03	1.49530389E+04	1.57147713E+04	.242
31	8.00000000E-02	4.35888705E+04	5.87619776E+04	3.03391215E+04	.596
32	8.00000000E-02	-2.50637860E+03	7.18079144E+03	1.78570056E+04	.257
33	8.00000000E-02	2.87554673E+04	2.57346065E+04	2.03771158E+04	.357
34	8.00000000E-02	-3.42439653E+03	5.06209130E+03	1.78151407E+04	.254
35	8.00000000E-02	2.26752600E+04	1.83893413E+04	1.71342243E+04	.290
36	8.00000000E-02	2.69002263E+04	-4.83268891E+03	3.91794292E+03	.243
37	8.00000000E-02	2.87483068E+03	1.93561278E+04	1.40606685E+04	.243
38	8.00000000E-02	2.63552557E+03	-1.91303771E+03	-1.02562757E+04	.146
39	8.00000000E-02	1.51469476E+04	-2.19030748E+03	-9.59526148E+02	.131
40	8.00000000E-02	1.30294806E+03	1.44485183E+04	7.15057833E+03	.149
41	8.00000000E-02	1.83626793E+04	-5.63499201E+02	3.74387010E+03	.158
42	8.00000000E-02	4.20854356E+02	1.04146023E+04	1.04124694E+04	.166
43	8.00000000E-02	-1.56781222E+03	3.46175037E+01	-7.04178522E+03	.098
44	0.	8.05640563E+03	1.23674903E+04	7.24105013E+02	.088
45	0.	2.33274627E+04	-1.15898886E+03	2.42386779E+03	.194
46	0.	8.80038797E+03	3.46549299E+04	7.29325859E+03	.269
47	0.	2.63632702E+04	1.88714634E+04	1.42352779E+04	.273
48	0.	6.72885745E+03	2.07455596E+04	1.11625158E+04	.213
49	0.	8.75070007E+03	1.07035892E+04	4.78419938E+03	.103
50	0.	1.13859333E+04	-1.02580873E+03	6.60627481E+03	.132
51	0.	-5.10034330E+01	9.75702568E+02	9.86103548E+03	.137
52	0.			1.28477220E+01	.000
53	0.			-1.81272728E+02	.003
54	0.			-1.14818926E+02	.002
55	0.			-6.27135155E+01	.001
56	0.			-2.28705408E+02	.003
57	0.			-1.36676647E+02	.002
58	0.			-1.80423820E+02	.002
59	0.			1.72756006E+01	.000
60	0.			-7.84721263E+01	.001
61	0.			-1.13271832E+02	.002
62	0.			2.96383590E+02	.004
63	0.			8.41024049E+01	.001
64	0.			-3.76413662E+02	.005
65	0.			5.52519268E+01	.001
66	0.			-1.95333602E+02	.003
67	0.			7.02486470E+02	.010
68	0.			4.32835720E+02	.006
69	0.			1.40701232E+02	.002
70	0.			-2.56738822E+02	.004
71	0.			-1.09855052E+02	.002
72	0.			4.83589727E+02	.007
73	0.			2.95165102E+02	.004
74	0.			9.07906148E+02	.013
75	0.			3.78535485E+02	.005

76	0.	4.16745893E+02	.006
77	0.	3.00391464E+02	.004
78	0.	1.49978070E+02	.002
79	0.	2.73711496E+01	.000
80	0.	2.46599706E+02	.003
81	0.	6.47576586E+02	.009
82	0.	2.84429294E+02	.004
83	0.	1.02297549E+03	.014
84	0.	2.64763952E+00	.000
85	0.	2.59777455E+02	.004
86	0.	1.06213113E+01	.000
87	0.	1.99867305E+02	.003
88	0.	-2.99372024E+01	.000
89	0.	2.66647844E+02	.004
90	0.	1.75794842E+02	.002
91	0.	1.79340630E+02	.002
92	0.	2.17037628E+01	.000
93	0.	7.36087862E+01	.001
94	0.	-4.23535523E+01	.001
95	0.	-1.22954355E+02	.002
96	0.	6.54967777E+01	.001
97	0.	-1.21180972E+01	.000
98	0.	8.26341197E+01	.001
99	0.	2.53623253E+01	.000
100	0.	-2.16393883E+01	.000

FLUTTER CONDITION NO. 1

OMEGA RADIANS/SEC.	H	DETERMINANT REAL PART	IMAGINARY PART
1.30000000E+01	-1.52400000E+03	-1.65518279E+00	-4.94874584E-01
1.30010000E+01	-1.52400000E+03	-1.65786301E+00	-4.92351907E-01
1.30000000E+01	-1.52430479E+03	-1.65568704E+00	-4.95181844E-01
1.28763940E+01	-6.74185963E+02	1.85874028E-01	2.54883280E-02
1.28773940E+01	-6.74185963E+02	1.83135841E-01	2.81350927E-02
1.28763940E+01	-6.74529694E+02	1.85222605E-01	2.51549911E-02
1.28935941E+01	-7.47048737E+02	1.52552191E-03	1.05529304E-04
1.28945941E+01	-7.47048737E+02	-1.21574871E-03	2.73547844E-03
1.28935941E+01	-7.47389038E+02	8.88561886E-04	-2.25531133E-04
1.28937637E+01	-7.47615479E+02	1.46354597E-07	7.29742031E-08
1.28947637E+01	-7.47615479E+02	-2.74119069E-03	2.62985773E-03
1.28937637E+01	-7.47955754E+02	-6.36699215E-04	-3.30969895E-04
1.28937637E+01	-7.47615556E+02	-1.84670789E-09	-9.57133316E-10

COMPLEX DETERMINANT CONVERGED TO 0

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FLUTTER CONDITION NO. 2

         OMEGA                    V                              DETERMINANT
      RADIANS/SEC.                                       REAL PART         IMAGINARY PART

     1.60000000E+01        3.00000000E+04         2.16230032E+12        1.78403936E+11
     1.60001000E+01        3.00000000E+04         2.16237759E+12        1.78626888E+11
     1.60000000E+01        3.00001000E+04         2.16222144E+12        1.78371611E+11
     1.63700218E+01        3.31041037E+04        -3.27148335E+11       -2.63165665E+10
     1.63701218E+01        3.31041037E+04        -3.27044046E+11       -2.60730816E+10
     1.63700218E+01        3.31042037E+04        -3.27251966E+11       -2.63530854E+10
     1.63269866E+01        3.27451099E+04        -4.73514894E+09       -3.88001511E+08
     1.63270866E+01        3.27451099E+04        -4.63409246E+09       -1.46901621E+08
     1.63269866E+01        3.27452099E+04        -4.83576442E+09       -4.24019932E+08
     1.63263488E+01        3.27397631E+04        -1.13681635E+06       -1.07269195E+05
     1.63264488E+01        3.27397631E+04         9.98712087E+07        2.40956999E+08
     1.63263488E+01        3.27398631E+04        -1.01707606E+08       -3.61182344E+07
     1.63263486E+01        3.27397618E+04        -2.25676160E+01       -4.95125528E+00

COMPLEX DETERMINANT CONVERGED TO 0
G( 1) =   1.35505581E-01
G( 2) =   7.45198391E-02
G( 3) =   8.49230224E-01
G( 4) =   8.23529412E-02

VARIABLE MASS = WT =  1.74083190E+01
TOTAL STRUCTURAL MASS = TWT =   2.16900121E+01
PF = PENALTY FUNCTION =   1.70669955E+01
PFUNC = WT + PF =   3.44753144E+01

DESIGN VARIABLES 1-  7
     8.00000000E-02       8.00000000E-02       8.00000000E-02       8.00000000E-02
     8.00000000E-02       8.00000000E-02       1.00000000E-01
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH


    FIRST DERIVATIVES
    -4.76447230E+01  1.61089440E+01 -1.84375079E+02 -6.92156782E+01  1.43625230E+01  1.00487074E+01  9.95538285E+00

    CSAV
     8.00000000E-02  8.00000000E-02  8.00000000E-02  8.00000000E-02  8.00000000E-02  8.00000000E-02  1.00000000E-01

    DIRECTION COSINES
    -6.53541053E-01 -9.81064730E-03  2.12771296E-01  5.20632011E-01 -3.88819809E-02  2.64888934E-01 -4.29861108E-01

    PFUNC = WT+PF =  3.44753144E+01            DERIVATIVE OF PFUNC IN MOVE DIRECTION = -4.63659382E+01
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PF =  1.79536697E+01    WT =  1.38675366E+01    S =  7.86658203E-02

CONSTANTS
 2.85886570E-02  7.92282374E-02  9.67378285E-02  1.20955944E-01
 7.69413171E-02  1.00837705E-01  6.61846233E-02

Q =   1.64043293E-01
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APPENDIX F – Continued

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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
    -9.18447002E+01  1.78083932E+01 -1.50456864E+02 -5.74184544E+01  1.68736125E+01  1.52404534E+00  4.01218481E+00
    CSAV
     2.65886570E-02  7.92282374E-02  9.67378285E-02  1.20955944E-01  7.69413171E-02  1.00837705E-01  6.61846233E-02
    DIRECTION COSINES
     4.86490842E-03 -7.66914803E-02 -2.52426762E-01  9.17604393E-01 -5.35713568E-02 -2.87992906E-01 -5.06739848E-02
    PFUNC = WT+PF =  3.18212064E+01          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -1.72611347E+01

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************************************************************************************************************************
PF =  1.82378729E+01   WT =  1.28766748E+01   S =  8.59765625E-02


CONSTANTS
 2.90069251E-02  7.26345675E-02  7.50350433E-02  1.99848416E-01
 7.23354360E-02  7.60770652E-02  6.18278483E-02

Q =   5.18122933E-02
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
    -8.10092045E+01 -3.66302861E-01 -1.41112507E+02 -4.09784484E+01 -2.32574205E+00 -5.15947087E+00  3.97114883E+00

    CSAV
     2.90069251E-02  7.26345675E-02  7.50350433E-02  1.99848416E-01  7.23354360E-02  7.60770652E-02  6.18278483E-02

    DIRECTION COSINES
    -3.09511542E-02 -6.41062493E-02 -1.25597979E-01  9.78484000E-01  4.50198065E-02 -1.35373119E-01 -3.70586015E-02

    PFUNC = WT+PF =   3.11145478E+01          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -1.86175998E+01


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PF =   1.76475280E+01    WT =   1.25229626E+01    S =   1.26882227E-01

CONSTANTS
 2.50785049E-02  6.45006239E-02  5.90988921E-02  3.24000644E-01
 7.80476493E-02  5.89006224E-02  5.71257704E-02

Q =    2.75630014E-02
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************************************************************************************************************
MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
    -4.52261527E+01 -9.37355612E+00 -6.82339291E+01 -1.18721890E+01 -1.01545903E+01 -8.09195604E+00  1.36471441E+00
    CSAV
     2.50785049E-02  6.45006239E-02  5.90988921E-02  3.24000644E-01  7.80476493E-02  5.89006224E-02  5.71257704E-02
    DIRECTION COSINES
     2.21049775E-02  4.27656035E-02  3.32516446E-01 -9.37331781E-01  6.08469151E-03  9.16656205E-02  9.20917302E-03
    PFUNC = WT+PF =   3.01704906E+01          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -1.39840528E+01

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************************************************************************************************************
PF =   1.61892990E+01    WT =   1.33129592E+01    S =   1.12667773E-01

CONSTANTS
 2.75690235E-02  6.93189292E-02  9.65627797E-02  2.18393560E-01
 7.87331979E-02  6.92283838E-02  5.81633474E-02

Q =   1.99944248E-02

QUADRATIC CONVERGENCE TEST SATISFIED

CTEST =   5.48747791E-01

CURRENT VALUE OF R IS   8.33333333E-03

    PF =   5.39643301E-01
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
     8.96510525E+01  1.76850118E+01  2.73129881E+01  9.08761088E+00  1.76864582E+01  3.58311057E+01  9.67733046E+00

    CSAV
     2.75590235E-02  6.93189292E-02  9.65627797E-02  2.18393560E-01  7.87331979E-02  6.92283839E-02  5.81633474E-02

    DIRECTION COSINES
    -7.09254871E-02 -2.15873336E-01 -2.37567325E-01  8.77943235E-01 -2.44036266E-01 -2.01677519E-01 -1.44630764E-01

    PFUNC = WT+PF =  1.38526025E+01          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -2.16220050E+01

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YIELD STRESS EXCEEDED - REDUCE S OR DC

YIELD STRESS EXCEEDED - REDUCE S OR DC

YIELD STRESS EXCEEDED - REDUCE S OR DC

YIELD STRESS EXCEEDED - REDUCE S OR DC

YIELD STRESS EXCEEDED - REDUCE S OR DC

PF =  8.44709581E-01   WT =  1.03588788E+01   S =  1.32712656E-01

CONSTANTS
  1.81561810E-02  4.06698055E-02  6.50345890E-02  3.34907738E-01
  4.63464969E-02  4.24632246E-02  3.89690145E-02

Q =   5.57380646E+00
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
     7.13892993E+01 -1.43956447E+00  1.62956714E+01  8.29495562E+00 -1.17549420E+01  1.92283699E+01  9.31311605E+00
    CSAV
     1.81561810E-02  4.06698055E-02  6.50345890E-02  3.34907738E-01  4.63464969E-02  4.24632246E-02  3.89690145E-02
    DIRECTION COSINES
    -5.30833009E-02 -6.37019736E-02  1.73838728E-01 -9.63170553E-01 -2.30661415E-02  9.69074774E-02 -1.59008483E-01
    PFUNC = WT*PF =  1.12035884E+01          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -8.20710182E+00

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********************************************************************************************************************
PF =  1.25368629E+00   WT =  8.99772330E+00   S =  1.54793945E-01
CONSTANTS
 9.93920742E-03  3.08091256E-02  9.19437715E-02  1.85814768E-01
 4.27759978E-02  5.74639154E-02  1.43554641E-02
Q =   6.14453544E-01
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

     FIRST DERIVATIVES
      8.29644200E+00 -2.73476190E+01 -8.90740203E+00 -2.00359211E+00 -4.62942755E+01 -1.77892430E+01  4.57757377E+00

     CSAV
      9.93920742E-03  3.08091256E-02  9.19437715E-02  1.85814768E-01  4.27759978E-02  5.74639154E-02  1.43554641E-02

     DIRECTION COSINES
     -2.36143945E-02 -2.37015034E-02 -1.46303979E-01  9.51104154E-01  1.50591142E-01 -2.23803880E-01 -1.05244796E-02

     PFUNC = WT+PF =  1.02514096E+01          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -3.09586260E+00

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PF =  1.32767147E+00   WT =  8.83550728E+00   S =  4.87297119E-02

CONSTANTS
 8.78848478E-03  2.96541582E-02  8.48144207E-02  2.32161800E-01
 5.01142608E-02  4.65580168E-02  1.38426092E-02

Q =   8.40189018E-02
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
    -1.16041969E+01 -2.55441432E+01 -1.81219271E+01 -4.31209769E+00 -4.45435802E+01 -3.21338889E+01  4.35989341E+00

    CSAV
     8.78648478E-03  2.96541582E-02  8.48144207E-02  2.32161800E-01  5.01142608E-02  4.65580168E-02  1.38426092E-02

    DIRECTION COSINES
    -9.53857229E-02 -3.69600117E-01 -1.55684548E-01  8.49934067E-01  3.21887432E-01  1.44893096E-02 -6.20504704E-02

    PFUNC = WT+PF =  1.01631788E+01          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -5.15901668E+00


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PF =  1.43897835E+00   WT =  8.61542527E+C0   S =  3.59274514E-02

CONSTANTS
 5.36151885E-03  1.63753680E-02  7.92210717E-02  2.62697764E-01
 6.16788559E-02  4.70785807E-02  1.16132939E-02

) =   2.00844089E-02
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
    -3.05122029E+01 -2.00793042E+01 -1.59887825E+01 -3.19552498E+00 -3.04689999E+01 -2.42540282E+01  1.74765827E+00

    CSAV
     5.36151885E-03  1.63753680E-02  7.92210717E-02  2.62697764E-01  6.16788559E-02  4.70785807E-02  1.16132939E-02

    DIRECTION COSINES
     8.96179560E-04 -6.11478726E-03  1.89659179E-01 -9.67738028E-01 -8.19220962E-02  1.43932304E-01 -6.82448815E-03

    PFUNC = WT+PF =  1.00544036E+01          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -9.62614161E-01

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PF =  1.43114843E+00   WT =  8.61307749E+00   S =  2.07052338E-02

CONSTANTS
 5.38007446E-03  1.62487599E-02  8.31480093E-02  2.42660522E-01
 5.99826398E-02  5.00587327E-02  1.14719913E-02

 5 ONEDIMENSIONAL  SEARCHES HAVE BEEN CARRIED OUT FOR R =   8.33333333E-03 - CONVERGENCE ASSUMED

CTEST =  1.42484692E-01

CURRENT VALUE OF R IS  2.77777778E-04

    PF =  4.77049478E-02
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
     8.90576021E+01  1.69519170E+01  2.75700224E+01  9.22809887E+00  1.66573179E+01  3.50824887E+01  9.71625900E+00

    CSAV
     5.38007446E-03  1.62487599E-02  8.31480093E-02  2.42660522E-01  5.99826398E-02  5.00587327E-02  1.14719913E-02

    DIRECTION COSINES
    -3.45168085E-02 -1.23519421E-01 -1.18768866E-01  9.36961847E-01  1.99259555E-01 -2.10527262E-01 -8.67288801E-02

    PFUNC = WT+PF =  8.66078244E+00          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -4.69907885E+00


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PF =  1.10239157E-01   WT =  8.25096652E+00   S =  7.42010581E-02

CONSTANTS
 2.81889075E-03  7.08348816E-03  7.43352338E-02  3.12184083E-01
 7.47679096E-02  3.44373871E-02  5.03661664E-03

Q =   6.21946263E-01
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
     4.28383481E+01  1.70236251E+01  6.03898989E+00  2.16784186E+00  1.70013711E+01  2.27204855E+00  8.85307172E+00

    CSAV
     2.81389075E-03  7.08348816E-03  7.43352338E-02  3.12184083E-01  7.47679096E-02  3.44373871E-02  5.03661664E-03

    DIRECTION COSINES
    -1.13892832E-02 -3.14479274E-02 -4.04122903E-02 -9.62395379E-01 -8.91050440E-02  2.50513758E-01 -1.86129564E-02

    PFUNC = WT+PF =  8.36120568E+00         DERIVATIVE OF PFUNC IN MOVE DIRECTION = -4.56858715E+00

V .LT. VCR - REDUCE S OR DC

PF =  1.52567961E-01   WT =  8.12567696E+00   S =  2.69601076E-02

CONSTANTS
 2.51183444E-03  6.23564865E-03  7.32457141E-02  2.86237800E-01
 7.23656280E-02  4.11912650E-02  4.53480934E-03

Q =   2.07127326E-01
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

     FIRST DERIVATIVES
     -2.61996438E+01  1.63682541E+01 -3.34179262E+01 -1.13418626E+01  1.70131851E+01 -4.09802847E+01  9.09657324E+00

     CSAV
      2.51183444E-03  6.23564865E-03  7.32457141E-02  2.86237800E-01  7.23656280E-02  4.11912650E-02  4.53480934E-03

     DIRECTION COSINES
     -7.01888253E-02 -1.61038277E-01  4.52596311E-02 -9.21134982E-01 -7.97158862E-02  3.14748633E-01 -1.14807620E-01

     PFUNC = WT+PF =  8.27824492E+00          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -7.33926089E+00


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PF =  2.13839542E-01    WT =  7.98708344E+00    S =  1.73225310E-02

CONSTANTS
 1.29598634E-03  3.44605811E-03  7.40297255E-02  2.70281411E-01
 7.09847471E-02  4.66435080E-02  2.54605077E-03

Q =   3.79735672E-02
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
    -1.08561239E+02  6.74357929E+00 -7.47120015E+01 -2.49016911E+01  7.11201041E+00 -7.89737757E+01  5.38498272E+00

    CSAV
     1.29598634E-03  3.44605811E-03  7.40297255E-02  2.70281411E-01  7.09847471E-02  4.66435080E-02  2.54605077E-03

    DIRECTION COSINES
    -2.47892703E-02 -5.76391701E-02  2.92258401E-01 -9.48336199E-01 -4.08448504E-02  8.50838588E-02 -4.89809505E-02

    PFUNC = WT+PF =  8.20092298E+00          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -3.60146530E+00


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PF =  2.20205830E-01   WT =  7.94770909E+00   S =  1.85038254E-02

CONSTANTS
 8.37290009E-04  2.37951297E-03  7.94376239E-02  2.52733563E-01
 7.02289611E-02  4.82178848E-02  1.63971582E-03

Q =   3.56504335E-03

QUADRATIC CONVERGENCE TEST SATISFIED

CTEST =  2.69598584E-02

CURRENT VALUE OF R IS  9.25925926E-06

    PF =  7.34019432E-03
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

    FIRST DERIVATIVES
     8.74822641E+01  1.74992070E+01  2.69064986E+01  8.95420717E+00  1.75359872E+01  3.45369993E+01  9.53801791E+00

    CSAV
     8.37290009E-04  2.37951297E-03  7.94376239E-02  2.52733563E-01  7.02289611E-02  4.82178848E-02  1.63971582E-03

    DIRECTION COSINES
    -1.60727962E-02 -5.35771336E-02  3.17112573E-01 -9.45421997E-01 -3.12506885E-02  2.21706925E-02 -3.19354704E-02

    PFUNC = WT+PF =  7.95504928E+00          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -2.37005112E+00

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YIELD STRESS EXCEEDED - REDUCE S OR DC

PF =  1.99558824E-02   WT =  7.87573022E+00   S =  2.90591302E-02

CONSTANTS
 3.70228531E-04  8.22608066E-04  8.86526394E-02  2.25260422E-01
 6.93206433E-02  4.68621459E-02  7.11698825E-04

Q =   7.69745418E-02
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MOVE DIRECTION DATA FOR ONE-DIMENSIONAL SEARCH

     FIRST DERIVATIVES
      4.04097992E+01 -2.24033567E+01  1.12820525E+01  5.53638848E+00 -3.38478251E+01  1.55764632E+00  7.55621629E+00

     CSAV
      3.70228531E-04  8.22608066E-04  8.86526394E-02  2.25260422E-01  6.93208433E-02  4.88621459E-02  7.11698825E-04

     DIRECTION COSINES
     -1.64534120E-02 -9.12514078E-03 -4.58476942E-01  8.80221346E-01  2.33541123E-02  1.14228288E-01 -3.25848984E-02

     PFUNC = WT+PF =  7.89568610E+00          DERIVATIVE OF PFUNC IN MOVE DIRECTION = -1.74974904E+00


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PF =  2.99900976E-02   WT =  7.85465948E+00   S =  9.73901463E-03

CONSTANTS
 2.09988510E-04  7.33738187E-04  8.41875258E-02  2.33832911E-01
 6.95482893E-02  4.99746169E-02  3.94354023E-04

Q =   3.33085777E-03

QUADRATIC CONVERGENCE TEST SATISFIED

CTEST =  3.80360564E-03
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THE FOLLOWING INFORMATION IS FOR THE FINAL DESIGN

ESTIMATED MINIMUM MASS LESS THAN TWO PERCENT LOWER THAN PRESENT MASS
DESIGN CONSIDERED CONVERGED


FINAL MASSES
WT =   7.85465948E+00     TWT =  1.21363526E+01


FINAL CONSTANTS
      2.09988510E-04       7.33738187E-04       8.41875258E-02       2.33832911E-01
      6.95482893E-02       4.99746169E-02       3.94354023E-04
```

DISPLACEMENT FIELD

NODE	U	V	W
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	0.	0.
5	0.	0.	0.
6	0.	0.	0.
7	0.	0.	0.
8	1.21085035E-02	-2.46531756E-02	2.55321834E-01
9	-6.01553099E-02	-1.86661130E-01	8.89164093E-01
10	-1.21946249E-02	-8.48683083E-02	3.84621291E+00
11	-9.91146351E-02	-4.09886713E-01	5.17003147E+00
12	-1.43105221E-01	-8.64434870E-01	6.59986772E+00
13	-2.50449039E-01	-1.35678395E+00	9.27805305E+00
14	-2.02717061E-01	-1.55733888E+00	1.37206051E+01
15	1.47679890E-02	-2.50810812E-01	1.72790998E+01
16	-5.27353091E-02	-1.54261930E-01	1.07070674E+01
17	-2.20086136E-01	-6.44199182E-01	1.40111650E+01
18	-2.70365963E-02	-1.89191289E-01	2.23414723E+01
19	-3.76903914E-01	-1.18780571E+00	2.87992996E+01
20	-5.18865742E-01	-1.88170709E+00	4.06552898E+01
21	-5.55575599E-02	-3.88919251E-01	5.28269445E+01
22	-1.32444931E-01	-3.36567897E-01	4.89379592E+01
23	-5.13003639E-01	-1.28913188E+00	5.88925485E+01
24	-6.45782685E-01	-1.76026816E+00	6.75251788E+01
25	-2.02726757E-01	-4.16418009E-01	8.89821717E+01
26	-1.41068539E-01	-3.68208299E-01	8.00398039E+01
27	-6.48381469E-01	-1.34948293E+00	9.21558754E+01
28	-7.71161005E-01	-1.56078891E+00	1.02001100E+02
29	-1.94689051E-01	-4.94276247E-01	1.22672186E+02
30	-2.02324533E-01	-4.22698095E-01	1.14733469E+02
31	-6.42413988E-01	-1.18597780E+00	1.26463715E+02
32	-6.98877576E-01	-1.26569538E+00	1.37688707E+02
33	-2.58856894E-01	-4.55268992E-01	1.53018350E+02
34	-2.60546203E-01	-4.72114238E-01	1.45670963E+02
35	-6.05938928E-01	-1.07017004E+00	1.58397578E+02
36	-2.65699829E-01	-4.85874127E-01	1.75572274E+02
37	-2.94635219E-01	-4.93677705E-01	1.77823497E+02
38	-2.63683492E-01	-4.61850654E-01	1.96483968E+02

STRESS FIELD

ELEMENT	THICKNESS	SIGMA X	SIGMA Y	SIGMA XY	STRESS RATIO
1	2.09988510E-04	1.68539199E+03	7.52591502E+03	3.67231398E+01	.055
2	2.09988510E-04	1.20582686E+04	4.01942287E+04	1.65622165E+03	.287
3	2.09988510E-04	1.57474521E+04	7.67038519E+02	2.64052142E+03	.128
4	2.09988510E-04	9.12963185E+03	1.36380082E+04	-1.57908600E+03	.099
5	2.09988510E-04	1.20578689E+04	4.01928962E+04	2.60617471E+03	.288
6	2.09988510E-04	1.80392514E+04	4.51303911E+04	-1.63563345E+04	.388
7	2.09988510E-04	2.41016932E+04	-3.45278612E+03	1.91605802E+03	.210
8	2.09988510E-04	9.04574327E+04	2.60568437E+04	-2.78124601E+04	.752
9	2.09988510E-04	8.59346592E+03	1.71780321E+04	1.04474006E+03	.120
10	2.09988510E-04	3.56113423E+03	1.57428955E+04	1.48193267E+04	.235
11	2.09988510E-04	2.48692821E+04	8.98880596E+03	-1.84641811E+04	.310
12	2.09988510E-04	3.48471553E+03	6.86836434E+03	-2.20021656E+03	.057
13	1.90842852E-02	3.87885219E+04	1.29295073E+05	7.06388226E+03	.925
14	9.90901167E-03	9.24726378E+04	3.38531732E+04	2.30147254E+04	.722
15	8.41875258E-02	1.36457810E+04	2.63076043E+04	1.89969436E+04	.320
16	8.41875258E-02	4.25835019E+04	8.92363295E+03	-1.53430018E+04	.377
17	8.41875258E-02	2.12958480E+04	-7.97383296E+02	6.66142026E+03	.197
18	3.13597115E-02	1.53920867E+04	2.32057781E+04	8.67109695E+02	.164
19	5.57853791E-02	4.13678866E+04	1.37892955E+05	1.40009422E+04	1.000
20	4.20224689E-02	9.33458492E+04	7.37150610E+04	4.75522871E+04	.948
21	8.41875258E-02	1.65940361E+04	5.76761123E+04	2.61043574E+04	.548
22	8.41875258E-02	5.15651075E+04	1.15867340E+04	2.23507688E+04	.486
23	1.34543169E-01	1.09293461E+04	2.21432102E+04	1.87745872E+04	.302
24	1.50118030E-01	3.44329759E+04	1.47767823E+04	-2.39634893E+04	.409
25	5.66688614E-02	3.37263042E+04	-7.87165484E+03	7.06292118E+03	.321
26	2.55191384E-02	3.18870229E+03	1.25924971E+04	-1.00004406E+03	.092
27	4.69345730E-02	4.02523730E+04	-5.93035552E+03	3.44121558E+02	.348
28	9.36591574E-02	1.32574284E+04	2.94023009E+04	2.10598113E+04	.356
29	2.16254230E-02	1.58124406E+04	1.17544996E+04	2.64990274E+02	.114
30	1.67981980E-02	6.40241530E+03	2.13413843E+04	2.24912535E+04	.347
31	3.33864074E-02	6.83331508E+04	1.04004560E+05	4.79768764E+04	.989
32	1.67981980E-02	-8.54922009E+02	1.33342797E+04	2.27072945E+04	.333
33	3.33864074E-02	3.85269326E+04	3.30938482E+04	2.38194718E+04	.439
34	1.67981980E-02	-1.53399382E+03	3.41912612E+03	2.73012242E+04	.380
35	3.33864074E-02	3.52602484E+04	2.12529651E+04	1.37548736E+04	.311
36	4.44452137E-02	5.13210320E+04	1.01808320E+03	-1.77166131E+03	.407
37	2.78570043E-02	2.02139924E+04	3.54721807E+04	2.30313406E+04	.403
38	1.12687948E-02	1.45046779E+04	6.15648817E+03	-1.42563004E+04	.222
39	4.44452137E-02	3.30301166E+04	-3.15754974E+03	-4.92950617E+03	.286
40	3.89158106E-02	2.02266264E+04	3.00306974E+04	1.20873941E+04	.270
41	2.85481797E-02	4.19628409E+04	6.48478751E+03	9.21389975E+02	.313
42	1.74893734E-02	8.55935930E+03	2.25134651E+04	2.13456674E+04	.335
43	6.43056705E-03	-2.82582830E+03	6.32466772E+03	-1.38409772E+04	.202
44	0.	1.85151709E+04	1.55977337E+04	1.97348821E+03	.141
45	0.	3.21742527E+04	-4.04276589E+03	1.23684595E+03	.276
46	0.	2.05094198E+04	3.51846618E+04	1.11433440E+04	.289
47	0.	2.85103173E+04	1.69086564E+04	1.24256152E+04	.263
48	0.	1.16555921E+04	1.49424233E+04	1.19192738E+04	.198
49	0.	1.28570621E+04	1.08200067E+04	4.67318584E+03	.116
50	0.	1.15373558E+04	-7.75795391E+02	5.52095955E+03	.122
51	0.	3.74057913E+03	3.23671186E+03	7.78075736E+03	.111
52	0.			1.28348423E+02	.002
53	0.			-6.56696777E+01	.001
54	0.			-1.23360797E+02	.002
55	0.			1.38288508E+02	.002
56	0.			-2.75572388E+01	.000
57	0.			-1.33191995E+02	.002
58	0.			4.56962265E+01	.001
59	0.			1.87350146E+02	.003
60	0.			4.40926403E+01	.001
61	0.			-6.22144092E+01	.001
62	0.			2.42113980E+02	.003
63	0.			2.80038690E+01	.000
64	0.			-2.87600105E+02	.004
65	0.			2.58579764E+02	.004
66	0.			-2.33077181E+02	.003
67	0.			7.11321087E+02	.010
68	0.			4.41150999E+02	.006
69	0.			6.49008724E+01	.001
70	0.			-3.41846131E+02	.005
71	0.			-3.42478651E+01	.000
72	0.			1.24288636E+02	.002
73	0.			-6.26443746E+01	.001
74	0.			1.10219749E+03	.015
75	0.			4.81947705E+02	.007

76	0.	5.20228213E+02	.007
77	0.	4.71908423E+02	.007
78	0.	2.34316851E+01	.000
79	0.	-9.84214466E+01	.001
80	0.	3.46484796E+02	.005
81	0.	7.69012167E+02	.011
82	0.	2.26797699E+02	.003
83	0.	1.24438551E+03	.017
84	0.	-1.70628456E+02	.002
85	0.	2.72799436E+02	.004
86	0.	-9.33583139E+01	.001
87	0.	1.47736094E+02	.002
88	0.	-8.60444918E+01	.001
89	0.	3.34191846E+02	.005
90	0.	1.97960120E+02	.003
91	0.	1.43509462E+02	.002
92	0.	1.39529098E+01	.000
93	0.	4.38529326E+01	.001
94	0.	-7.66133348E+01	.001
95	0.	-1.36320931E+02	.002
96	0.	6.42456128E+01	.001
97	0.	-1.39172599E+01	.000
98	0.	8.00876836E+01	.001
99	0.	2.22888578E+01	.000
100	0.	-2.82508018E+01	.000

FLUTTER CONDITION NO. 1

OMEGA RADIANS/SEC.	H	DETERMINANT REAL PART	IMAGINARY PART
1.04197386E+01	1.51121235E+03	-8.93463018E-11	-4.62214729E-10
1.04207386E+01	1.51121235E+03	-4.81091907E-04	6.49681850E-04
1.04197386E+01	1.51075774E+03	-1.47102803E-04	-8.77791958E-05
1.04197386E+01	1.51121236E+03	-8.69289025E-11	-5.18443164E-11

COMPLEX DETERMINANT CONVERGED TO 0

FLUTTER CONDITION NO. 2

OMEGA RADIANS/SEC.	V	DETERMINANT REAL PART	IMAGINARY PART
1.46776783E+01	3.61720131E+04	6.72803494E+04	1.30016701E+04
1.46777783E+01	3.61720131E+04	4.93399887E+07	1.24282601E+08
1.46776783E+01	3.61721131E+04	-4.71849673E+07	-1.88042691E+07
1.46776783E+01	3.61720133E+04	1.09921274E+00	1.73652209E-01

COMPLEX DETERMINANT CONVERGED TO 0
G(1) = 7.62803906E-04
G(2) = 1.62335815E-01
G(3) = 4.42912923E-02
G(4) = 8.03546137E-04

Example 3 Input

```
1  EXAMPLE  3 BUILT UP WING WITH A DIVERGENCE CONSTRAINT
 $OPTION  IPRINT=1,  IZCOR=-1, IOPT=2,   IPUNCH=0$
 $DIMNSHN  NEL=218, NNOD=69, NTSEG=2, NSN=25, NEIG=6, NVEC=9 , NMAT=2,
      NDV=2, NOC=8 , NF=1, NYS=7, NYC=6, NS=6, NXP=8, NL=2, NT=2, NFREE=2$
 $WNGEOM                    YTIP=794.4, XLR=503., XTR=2710.8, XLT=2883.6,XTT=3060.,
  YL(1)=391.2, 600., XL(1)=1873.1, 2473.2,  YT(1)=276.1, 453.6, XT(1)=2700.,
  2748.$
 $UNIT LUNIT=.0254 ,MUNIT=175.1268348,MNORM=1 ,G=386.4 $
 $FLUTER  OMINIT=0.00,DELOM=.000, SG=.0,
      HINIT=-2133.6, DELH=.3048,  HFIN=-24384.  ,
    KFK=2, HCR=1524.,MACH=.90,KMAX=2., KMIN=0., KMED=1., REF=100., NK=10 $
 $MATTER IMAT=2, RHO=1.09E-3, SIGMA1=1.25E5, SIGMA2=1.25E5,SIGMA12=7.217E4,
    E=1.54E7, U=.3  $
 $MATTER IMAT=1, RHO=7.45E-4, IFL=1, E=0.54E6, U=.3$
    1          2160.0        0.0       18.8
    2          2247.5        0.0       16.1
    3          2335.0        0.0       13.1
    4          2422.5        0.0       10.1
    5          2510.0        0.0        7.1
    6          1390.0       95.0       27.5
    7          1655.0       95.0       27.4
    8          1920.0       95.0       24.5
    9          2160.        95.0       18.2
   10          2247.5       95.0       15.6
   11          2335.        95.0       12.7
   12          2422.5       95.         9.8
   13          2510.        95.0        6.6
   14          1390.0      190.0       18.3
   15          1655.0      190.0       18.5
   16          1920.0      190.0       18.4
   17          2040.0      190.0       17.0
   18          2160.0      190.0       15.1
   19          2247.5      190.0       13.1
   20          2335.0      190.0       10.9
   21          2422.5      190.0        8.4
   22          2510.0      190.0        5.8
   23          1740.0      312.5       13.6
   24          2005.0      312.5       14.1
   25          2125.0      312.5       13.9
   26          2245.0      312.5       12.6
   27          2320.0      312.5       11.3
   28          2395.0      312.5        9.5
   29          2470.0      312.5        7.4
   30          2545.0      312.5        5.1
   31          2090.0      435.0        9.3
   32          2210.0      435.0        9.6
   33          2330.0      435.0        9.8
   34          2392.5      435.0        9.3
   35          2455.0      435.0        8.4
   36          2517.5      435.0        7.0
   37          2580.0      435.0        5.2
   38          2295.0      514.5        7.3
   39          2415.0      514.5        7.7
   40          2477.5      514.5        7.8
   41          2540.       514.5        7.3
   42          2602.5      514.5        6.2
   43          2665.       514.5        4.6
   44          2500.       594.0        5.3
   45          2562.5      594.         5.7
   46          2625.       594.0        5.8
   47          2687.5      594.         5.4
   48          2750.       594.0        4.1
   49          2547.5      6[illegible]5.5        2.5
```

	50		2672.5	615.5		5.4	
	51		2595.	637.0		2.6	
	52		2720.0	637.0		5.0	
	53		2803.3	642.7		3.8	
	54		2642.5	658.5		2.6	
	55		2778.3	678.0		4.3	
	56		2690.0	680.0		2.7	
	57		2856.65	691.35		3.4	
	58		2753.3	703.3		2.3	
	59		2836.7	719.0		3.7	
	60		2910.0	740.0		3.0	
	61		2816.65	746.65		1.9	
	62		2895.0	760.0		3.0	
	63		2880.0	760.0		1.5	
	64		1390.0	80.0		27.	
	65		1655.0	90.0		26.9	
	66		1920.0	40.0		24.	
	67		1390.		27.5		
	68		1655.		27.5		
1	69		1920.		24.5		
	1	4	14	15		.016680	2
	2	4	15	16		.021540	
	3	4	16	17		.053280	
	4	4	17	18		.034330	
	5	4	18	19		.067750	
	6	4	19	20		.043510	
	7	4	20	21		.024680	
	8	4	21	22		.014430	
	9	4	31	32		.031390	
	10	4	32	33		.012400	
	11	4	33	34		.033220	
	12	4	34	35		.037530	
	13	4	35	36		.039870	
	14	4	36	37		.048750	
	15	4	44	45		.018690	
	16	4	45	46		.014110	
	17	4	46	47		.012400	
	18	4	47	48		.012400	
	19	4	56	52		.012400	
	20	4	52	48		.012400	
	21	4	63	62		.042230	
	22	4	62	61		.013820	
	23	4	6	14		.093520	
	24	4	14	23		.012400	
	25	4	23	31		.012400	
	26	4	8	16		.119110	
	27	4	16	24		.069160	
	28	4	24	31		.128810	
	29	4	31	38		.029700	
	30	4	38	44		.023110	
	31	4	1	9		.094860	
	32	4	9	18		.090090	
	33	4	18	26		.063520	
	34	4	26	33		.043410	
	35	4	33	39		.070710	
	36	4	39	44		.079120	
	37	4	44	49		.080440	
	38	4	49	51		.027420	
	39	4	51	54		.041050	
	40	4	54	56		.033020	
	41	4	56	58		.031500	
	42	4	58	61		.018600	
	43	4	61	63		.019450	
	44	4	5	13		.041840	
	45	4	13	22		.035130	
	46	4	22	3		.083120	

47	4	30	37		.091110	
48	4	37	43		.07[illegible]310	
49	4	43	48		.046680	
50	4	48	53		.049660	
51	4	53	57		.041540	
52	4	57	60		.039780	
53	4	24	23		.026490	
54	4	15	23		.099230	
55	4	39	38		.015100	
56	4	32	38		.074420	
57	4	54	50		.012400	
58	4	50	47		.019930	
59	4	51	46		.012400	
60	4	49	45		.049050	
61	4	52	58		.046350	
62	4	50	46		.053270	
63	4	7	15		.117840	
64	4	13	12		.012400	
65	4	12	11		.014630	
66	4	11	10		.032190	
67	4	10	9		.030400	
68	4	4	12		.109950	
69	4	12	21		.079800	
70	4	3	11		.119030	
71	4	11	20		.066340	
72	4	2	10		.080030	
73	4	10	19		.049610	
74	4	26	25		.053580	
75	4	25	24		.041010	
76	4	17	25		.101090	
77	4	25	32		.074420	
78	4	30	29		.012400	
79	4	29	28		.047300	
80	4	28	27		.069940	
81	4	27	26		.094750	
82	4	21	29		.108030	
83	4	29	36		.049610	
84	4	20	28		.085310	
85	4	28	35		.049610	
86	4	19	27		.061900	
87	4	27	34		.049610	
88	4	43	42		.019030	
89	4	42	41		.017940	
90	4	41	40		.012400	
91	4	40	39		.012400	
92	4	36	42		.054130	
93	4	42	47		.064830	
94	4	35	41		.049610	
95	4	41	46		.049650	
96	4	34	40		.049610	
97	4	40	45		.049610	
98	4	53	55		.012400	
99	4	55	58		.012400	
100	4	57	59		.016300	
101	4	59	61		.019390	
102	4	52	55		.077850	
103	4	55	59		.077740	
104	4	59	62		.049630	
105	2	16	15	23	.030000	1
106	2	23	24	16	.033590	
107	2	15	14	23	.030000	
108	2	24	23	31	.244210	
109	2	33	32	38	.061470	
110	2	38	39	33	.204450	
111	2	32	31	38	.048280	
112	2	39	38	44	.097270	

113	2	56	52	50	.261580	
114	2	50	54	56	.030000	
115	2	52	46	47	.272760	
116	2	47	5[illegible]	52	.332450	
117	2	54	5[illegible]	46	.242670	
118	2	46	51	54	.040460	
119	2	50	47	46	.310920	
120	2	51	46	45	.111110	
121	2	45	49	51	.030000	
122	2	49	45	44	.076350	
123	2	8	7	15	.030000	
124	2	15	16	8	.042590	
125	2	7	6	14	.087540	
126	2	14	15	7	.030000	
135	2	13	12	21	.127820	2
136	2	21	22	13	.119270	2
137	2	12	11	20	.131840	2
138	2	20	21	12	.205720	2
139	2	11	1[illegible]	19	.077650	2
140	2	19	2[illegible]	11	.194550	2
141	2	10	9	18	.124470	2
142	2	18	19	10	.305070	2
143	2	18	17	25	032570	
144	2	25	26	18	.063580	
145	2	17	16	24	.047320	
146	2	24	25	17	.030000	
147	2	26	25	32	.059520	
148	2	32	33	26	.148880	
149	2	25	24	31	.030000	
150	2	31	32	25	.071740	
151	2	22	21	29	.184780	
152	2	29	3[illegible]	22	.0675439	
153	2	21	2[illegible]	28	.206820	
154	2	28	29	21	.162720	
155	2	20	19	27	.216760	
156	2	27	26	20	.188980	
157	2	19	18	26	.068210	
158	2	26	27	19	.191790	
159	2	30	29	36	.209970	
160	2	36	37	30	.116090	
161	2	29	28	35	.246740	
162	2	35	35	29	.206890	
163	2	28	27	34	.195760	
164	2	34	35	28	.276590	
165	2	27	26	33	.144570	
166	2	33	34	27	.250420	
167	2	37	36	42	.319000	
168	2	42	43	37	.124940	
169	2	36	35	41	.374970	
170	2	41	42	36	.240480	
171	2	35	34	40	.301430	
172	2	40	41	35	.264860	
173	2	34	33	39	.190800	
174	2	39	40	34	.239620	
175	2	43	42	47	.326770	
176	2	47	46	43	.111830	
177	2	42	41	46	.320380	
178	2	46	47	42	.297560	
179	2	41	4[illegible]	45	.187530	
180	2	45	46	41	.342800	
181	2	40	39	44	.074450	
182	2	44	45	40	.229860	
183	2	48	52	55	.259360	
184	2	55	53	48	.144640	
185	2	52	56	58	.045110	
186	2	58	55	52	.162570	

187	2	53	55	59	.152370	
188	2	59	57	53	.126890	
189	2	55	58	61	.03[illegible]000	
190	2	61	59	55	.121350	
191	2	57	59	62	.039010	
192	2	62	6[illegible]	57	.093390	
193	2	59	61	63	. 839272	
194	2	63	62	59	. 3	
127	2	5	4	12	14.6	2
128	2	12	13	5	14.6	2
129	2	4	3	11	8.0	2
130	2	11	12	4	8.0	2
131	2	3	2	10	6.0	2
132	2	10	11	3	6.0	2
133	2	2	1	9	4.75	2
134	2	9	1	2	4.75	2
195		67	68	64	1.81	
196		64	68	65	1.81	
197		68	69	65	2.6	
198		65	69	66	2.6	
199		69	1	66	3.0	
200		66	1	9	3.0	
201	4	64	67		1.	
202	4	65	68			
203		66	69			
204		67	68			
205		68	69			
206		69	1			
207		1	2			
208		2	3			
209		3	4			
210		4	5			
211		64	65			
212		65	66			
213		66	[illegible]			
217		6	7			
218		7	8			
214	1	64	6			
215	1	65	7			
1 216	1	66	8			

```
    1 101      2 101     3 101      4 101      5 100     67 100     68 101     69 101
    6    8    16    14 -1.       -1.        -1.        -1.         1    1    1    1
1  22   37    31    14  -1.       -1.        -1.        -1.        1    1    1    1
```

```
$TETA ITHETA=0$
VMASS       105   112   5.00.E-5
VMASS       123   162   5.00.E-5
CMASS        13    13    .94 5
CMASS        22    22    1.  17
CMASS        30    3.    .9775
CMASS        37    37    .7774
CMASS        43    43    .5 06
CMASS        48    48    .8 98
CMASS        53    53    .5 18
CMASS        57    57    .5 05
CMASS        60    60    .7  3
CMASS        14    14    2.  2
CMASS        23    23    1.  54
CMASS        31    3     .8 5
CMASS        38    38    .5 01
CMASS        44    44    .54 2
CMASS        45    47    .3040
CMASS        37    37   19.3
CMASS        22    22    9.6
1CMASS       30    3     9.6
1PLOAD      105   194   0.5
.           .239        .393        .548        .648        .748        .856
   5    8    8    7    6    5    3
   2    3    4    5    6    7
   1    2    3    4    5
  14   15   16   17   18    2   21   22
  23   24   25   26   27   28   29   3
  31   32   33   34   35   36   37
  38   39   40   41   42   43
  44   45   46   47   48
  56   55   57
12
$CONSTR FLUTTER=.T., GAGE .T.$
$OPTIMUM R=.125,RUC=20., (1) = 2*.12, TUL(1)=10., TUL(3)=.01$
     EXAMPLE 3
$NAM1 MACH=.90, NK=10,         KMAX=2., KMED=1., KMIN= .$
```

Example 3 Output

```
 EXAMPLE    3 BUILT UP WING WITH A DIVERGENCE CONSTRAINT

INPUT OPTIONS

    IPRINT = 1       1 - NORMAL PRINTOUT, 2 - EXTENDED PRINTOUT
    IZCOR =-1        0 - BICONVEX SYMMETRIC, -1 - INPUT Z COORDINATES
    IOPT = 2         1 - A SINGLE ANALYSIS, 2 - OPTIMIZATION
    IPUNCH = 0       1 - PUNCH A NASTRAN DECK, 0 - NO PUNCH

$DIMNSHN

NEL      =  218,

NNOD     =  69,

NTSEG    =  2,

NSN      =  25,

NEIG     =  6,

NVEC     =  9,

NMAT     =  2,

NDV      =  2,

NOC      =  8,

NF       =  1,

NYS      =  7,

NYC      =  6,

NS       =  6,

NXP      =  8,

NFREE    =  2,

NL       =  2,

NT       =  2,

$END

LEADING AND TRAILING EDGES CRANKS

         Y                XL               XT

   3.91200E+02     1.87310E+03
   6.00000E+02     2.47320E+03
   2.76100E+02                       2.70000E+03
   4.53600E+02                       2.74800E+03

WING DESCRIPTION

     ASPECT RATIO............AR =  1.61615439E+00
     SURFACE AREA..........AREA =  1.56190860E+06
     L.E. SWEEP ANGLE...ANGLE1 =            IIIII DEGREES
     SEMISPAN................SS =  7.94400000E+02
     SEMI-ROOT CHORD.......BREF =  1.10390000E+03
     TAPER RATIO..........TAPER =            IIIII
     DEPTH RATIO.............DR =            IIIII
```

```
$UNIT

G        =  0.3864E+03,

LUNIT    =  0.254E-01,

MUNIT    =  0.1751268348E+03,

MNORM    =  0.1E+01,

$END


FLUTTER CONDITION  1


SUBSONIC KERNEL FUNCTION AERODYNAMICS

     MACH NUMBER.................MACH =  9.00000000E-01
     AERO DATA TAPE NUMBER.......NTAPE =  17
     NUMBER OF K VALUES............NK =  10
     MAXIMUM K...................KMAX =  2.00000000E+00
     MEDIAN K....................KMED =  1.00000000E+00
     MINIMUM K...................KMIN =  0.
     GAIN FACTOR................IGAIN =  10
     STRUCTURAL DAMPING............SG =  0.
     REFERENCE FREQUENCY..........REF =  1.00000000E+02

     OMEGA INITIAL..............OMINIT =  0.                RADIANS/SEC.
     OMEGA INCREMENT.............DELOM =  0.                RADIANS/SEC.
     H INITIAL...................HINIT = -2.13360000E+03  METERS
     H INCREMENT..................DELH =  3.04800000E-01  METERS
     H LOWER BOUND................HFIN = -2.43840000E+04  METERS
     H CRITICAL....................HCR =  1.52400000E+03  METERS
     *
```

MATERIAL PROPERTIES

	Q11	Q21	Q22	Q31	Q32	Q33	SIGMA1	SIGMA2	SIGMA12	RHO
1	5.9341E+05	1.7802E+05	5.9341E+05	0.	0.	4.1538E+05	1.0000E+20	1.0000E+20	1.0000E+20	7.4500E-04
2	1.6923E+07	5.0769E+06	1.6923E+07	0.	0.	1.1846E+07	1.2500E+05	1.2500E+05	7.2170E+04	1.0900E-03

SEGMENT DATA

SEGMENT 1 IS DEFINED BY NODES 6 8 16 14 MATERIAL ORIENTATION I DEGREES

NODE	THICKNESS
6	-1.00000000E+00
7	-1.00000000E+00
8	-1.00000000E+00
14	-1.00000000E+00
15	-1.00000000E+00
16	-1.00000000E+00
64	-1.00000000E+00
65	-1.00000000E+00
66	-1.00000000E+00

SEGMENT 2 IS DEFINED BY NODES 22 37 31 14 MATERIAL ORIENTATION I DEGREES

NODE	THICKNESS
14	-1.00000000E+00
15	-1.00000000E+00
16	-1.00000000E+00
17	-1.00000000E+00
18	-1.00000000E+00
19	-1.00000000E+00
20	-1.00000000E+00
21	-1.00000000E+00
22	-1.00000000E+00
23	-1.00000000E+00
24	-1.00000000E+00
25	-1.00000000E+00
26	-1.00000000E+00
27	-1.00000000E+00
28	-1.00000000E+00
29	-1.00000000E+00
30	-1.00000000E+00
31	-1.00000000E+00
32	-1.00000000E+00
33	-1.00000000E+00
34	-1.00000000E+00
35	-1.00000000E+00
36	-1.00000000E+00
37	-1.00000000E+00

NODAL DATA

NODE	NRR	X	Y	Z	MASS
1	101	2.1600000E+03	0.	1.8800000E+01	2.7447395E+01
2	101	2.2475000E+03	0.	1.6100000E+01	2.0507061E+01
3	101	2.3350000E+03	0.	1.3100000E+01	2.4372212E+01
4	101	2.4225000E+03	0.	1.0100000E+01	3.4477668E+01
5	100	2.5100000E+03	0.	7.1000000E+00	3.1541671E+01
6	111	1.3900000E+03	8.0000000E+01	2.7500000E+01	9.2819732E+00
7	111	1.6550000E+03	8.0000000E+01	2.7400000E+01	2.3639105E+01
8	111	1.9200000E+03	8.0000000E+01	2.4500000E+01	1.3919257E+01
9	111	2.1600000E+03	9.5000000E+01	1.8200000E+01	2.5701180E+01
10	111	2.2475000E+03	9.5000000E+01	1.5600000E+01	2.4262793E+01
11	111	2.3350000E+03	9.5000000E+01	1.2700000E+01	2.8428599E+01
12	111	2.4225000E+03	9.5000000E+01	9.8000000E+00	4.2961380E+01
13	111	2.5100000E+03	9.5000000E+01	6.8000000E+00	1.7857667E+01
14	111	1.3900000E+03	1.9000000E+02	1.8300000E+01	1.8371339E+01
15	111	1.6550000E+03	1.9000000E+02	1.8500000E+01	2.5607186E+01
16	111	1.9200000E+03	1.9000000E+02	1.8400000E+01	1.6808617E+01
17	111	2.0400000E+03	1.9000000E+02	1.7000000E+01	6.2952060E+00
18	111	2.1600000E+03	1.9000000E+02	1.5100000E+01	7.9261266E+00
19	111	2.2475000E+03	1.9000000E+02	1.3100000E+01	7.3960339E+00
20	111	2.3350000E+03	1.9000000E+02	1.0900000E+01	6.4900369E+00
21	111	2.4225000E+03	1.9000000E+02	8.4000000E+00	5.1736981E+00
22	111	2.5100000E+03	1.9000000E+02	5.8000000E+00	1.2746041E+01
23	111	1.7400000E+03	3.1250000E+02	1.3600000E+01	1.9337256E+01
24	111	2.0050000E+03	3.1250000E+02	1.4100000E+01	1.4486338E+01
25	111	2.1250000E+03	3.1250000E+02	1.3900000E+01	1.0676654E+01
26	111	2.2450000E+03	3.1250000E+02	1.2600000E+01	8.7209530E+00
27	111	2.3200000E+03	3.1250000E+02	1.1300000E+01	6.6313278E+00
28	111	2.3950000E+03	3.1250000E+02	9.5000000E+00	5.9091546E+00
29	111	2.4700000E+03	3.1250000E+02	7.4000000E+00	4.7423350E+00
30	111	2.5450000E+03	3.1250000E+02	5.1000000E+00	1.2459784E+01
31	111	2.0900000E+03	4.3500000E+02	9.3000000E+00	8.8178452E+00
32	111	2.2100000E+03	4.3500000E+02	9.6000000E+00	6.1832226E+00
33	111	2.3300000E+03	4.3500000E+02	9.8000000E+00	5.7554521E+00
34	111	2.3925000E+03	4.3500000E+02	9.3000000E+00	4.3268049E+00
35	111	2.4550000E+03	4.3500000E+02	8.4000000E+00	4.1173610E+00
36	111	2.5175000E+03	4.3500000E+02	7.0000000E+00	3.4179432E+00
37	111	2.5800000E+03	4.3500000E+02	5.2000000E+00	2.1449067E+01
38	111	2.2950000E+03	5.1450000E+02	7.3000000E+00	3.6362544E+00
39	111	2.4150000E+03	5.1450000E+02	7.7000000E+00	2.9470765E+00
40	111	2.4775000E+03	5.1450000E+02	7.8000000E+00	2.7308566E+00
41	111	2.5400000E+03	5.1450000E+02	7.3000000E+00	2.8760280E+00
42	111	2.6025000E+03	5.1450000E+02	6.2000000E+00	2.5618949E+00
43	111	2.6650000E+03	5.1450000E+02	4.6000000E+00	1.5963918E+00
44	111	2.5000000E+03	5.9400000E+02	5.3000000E+00	1.9471361E+00
45	111	2.5625000E+03	5.9400000E+02	5.7000000E+00	1.6410419E+00
46	111	2.6250000E+03	5.9400000E+02	5.8000000E+00	1.8720393E+00
47	111	2.6875000E+03	5.9400000E+02	5.4000000E+00	1.6492469E+00
48	111	2.7500000E+03	5.9400000E+02	4.1000000E+00	1.4181713E+00
49	111	2.5475000E+03	6.1550000E+02	2.5000000E+00	3.0065604E-02
50	111	2.6[illegible]25000E+03	6.1550000E+02	5.4000000E+00	3.0405652E-01
51	111	2.5950000E+03	6.3700000E+02	2.6000000E+00	6.1915945E-02
52	111	2.7200000E+03	6.3700000E+02	5.0000000E+00	4.6153434E-01
53	111	2.8033000E+03	6.4270000E+02	3.8000000E+00	6.8915783E-01
54	111	2.6425000E+03	6.5850000E+02	2.6000000E+00	1.1124645E-01
55	111	2.7783000E+03	6.7800000E+02	4.3000000E+00	3.7315312E-01
56	111	2.6900000E+03	6.8000000E+02	2.7000000E+00	1.2502305E-01
57	111	2.8566500E+03	6.9135000E+02	3.4000000E+00	6.2958726E-01
58	111	2.7533000E+03	7.1330000E+02	2.3000000E+00	9.9937197E-02
59	111	2.8367000E+03	7.1900000E+02	3.7000000E+00	1.9795376E-01
60	111	2.9100000E+03	7.4000000E+02	3.0000000E+00	7.5660458E-01
61	111	2.8166500E+03	7.4665000E+02	1.9000000E+00	7.7093195E-02
62	111	2.8950000E+03	7.6000000E+02	3.0000000E+00	4.7475886E-02
63	111	2.8800000E+03	7.8000000E+02	1.5000000E+00	3.4246321E-02
64	111	1.3900000E+03	8.0000000E+01	2.7000000E+01	1.3000747E+01
65	111	1.6550000E+03	8.0000000E+01	2.6900000E+01	2.4479024E+01
66	111	1.9200000E+03	8.0000000E+01	2.4000000E+01	3.0779551E+01
67	100	1.3900000E+03	0.	2.7500000E+01	8.2936504E+00
68	101	1.6550000E+03	0.	2.7500000E+01	2.2517128E+01
69	101	1.9200000E+03	0.	2.4500000E+01	2.7533275E+01

LOAD DATA

NODE	XLOAD	YLOAD	ZLOAD
1	0.	0.	6.9270833E+02
2	0.	0.	2.0781250E+03
3	0.	0.	2.0781250E+03
4	0.	0.	2.0781250E+03
5	0.	0.	1.3854167E+03
6	0.	0.	2.4291667E+03
7	0.	0.	7.2875000E+03
8	0.	0.	4.8583333E+03
9	0.	0.	2.0781250E+03
10	0.	0.	4.1562500E+03
11	0.	0.	4.1562500E+03
12	0.	0.	4.1562500E+03
13	0.	0.	2.0781250E+03
14	0.	0.	7.5635417E+03
15	0.	0.	1.2697917E+04
16	0.	0.	9.0645833E+03
17	0.	0.	3.6750000E+03
18	0.	0.	4.7286458E+03
19	0.	0.	4.6302083E+03
20	0.	0.	4.6302083E+03
21	0.	0.	4.6302083E+03
22	0.	0.	2.3515625E+03
23	0.	0.	1.0820833E+04
24	0.	0.	9.0854167E+03
25	0.	0.	7.3500000E+03
26	0.	0.	6.0994792E+03
27	0.	0.	4.5937500E+03
28	0.	0.	4.5937500E+03
29	0.	0.	4.5937500E+03
30	0.	0.	2.1692708E+03
31	0.	0.	5.9502083E+03
32	0.	0.	5.2650000E+03
33	0.	0.	4.6327083E+03
34	0.	0.	3.2838542E+03
35	0.	0.	3.2838542E+03
36	0.	0.	3.2838542E+03
37	0.	0.	1.4661458E+03
38	0.	0.	3.1800000E+03
39	0.	0.	2.8321875E+03
40	0.	0.	2.4843750E+03
41	0.	0.	2.4843750E+03
42	0.	0.	2.4843750E+03
43	0.	0.	1.2421875E+03
44	0.	0.	1.7351042E+03
45	0.	0.	1.6901042E+03
46	0.	0.	2.0260417E+03
47	0.	0.	1.6901042E+03
48	0.	0.	1.2076783E+03
49	0.	0.	2.2395833E+02
50	0.	0.	8.9583333E+02
51	0.	0.	5.5989583E+02
52	0.	0.	1.4382950E+03
53	0.	0.	7.1926708E+02
54	0.	0.	6.7187500E+02
55	0.	0.	1.5426846E+03
56	0.	0.	7.5799167E+02
57	0.	0.	5.5603250E+02
58	0.	0.	8.2282458E+02
59	0.	0.	1.2166887E+03
60	0.	0.	1.4972917E+02
61	0.	0.	6.6059250E+02
62	0.	0.	5.0064125E+02
63	0.	0.	3.5010792E+02
64	0.	0.	0.
65	0.	0.	0.
66	0.	0.	0.
67	0.	0.	0.
68	0.	0.	0.
69	0.	0.	0.

TOTAL MASS IS 7.237223E+02

ELEMENT DATA

ELEMENT	NODES				SEGMENT	TYPE	THICKNESS	MATERIAL	THETA
1	14	15	-0	-0	0	4	1.6680000E-02	2	-0.
2	15	16	-0	-0	0	4	2.1540000E-02	2	-0.
3	16	17	-0	-0	0	4	5.3280000E-02	2	-0.
4	17	18	-0	-0	0	4	3.4330000E-02	2	-0.
5	18	19	-0	-0	0	4	6.7750000E-02	2	-0.
6	19	20	-0	-0	0	4	4.3510000E-02	2	-0.
7	20	21	-0	-0	0	4	2.4680000E-02	2	-0.
8	21	22	-0	-0	0	4	1.4430000E-02	2	-0.
9	31	32	-0	-0	0	4	3.1390000E-02	2	-0.
10	32	33	-0	-0	0	4	1.2400000E-02	2	-0.
11	33	34	-0	-0	0	4	3.3220000E-02	2	-0.
12	34	35	-0	-0	0	4	3.7530000E-02	2	-0.
13	35	36	-0	-0	0	4	3.9870000E-02	2	-0.
14	36	37	-0	-0	0	4	4.8750000E-02	2	-0.
15	44	45	-0	-0	0	4	1.8690000E-02	2	-0.
16	45	46	-0	-0	0	4	1.4110000E-02	2	-0.
17	46	47	-0	-0	0	4	1.2400000E-02	2	-0.
18	47	48	-0	-0	0	4	1.2400000E-02	2	-0.
19	56	52	-0	-0	0	4	1.2400000E-02	2	-0.
20	52	48	-0	-0	0	4	1.2400000E-02	2	-0.
21	63	62	-0	-0	0	4	4.2230000E-02	2	-0.
22	62	60	-0	-0	0	4	1.3820000E-02	2	-0.
23	6	14	-0	-0	0	4	9.3520000E-02	2	-0.
24	14	23	-0	-0	0	4	1.2400000E-02	2	-0.
25	23	31	-0	-0	0	4	1.2400000E-02	2	-0.
26	8	16	-0	-0	0	4	1.1911000E-01	2	-0.
27	16	24	-0	-0	0	4	6.9160000E-02	2	-0.
28	24	31	-0	-0	0	4	1.2881000E-01	2	-0.
29	31	38	-0	-0	0	4	2.9700000E-02	2	-0.
30	38	44	-0	-0	0	4	2.3110000E-02	2	-0.
31	1	9	-0	-0	0	4	9.4860000E-02	2	-0.
32	9	18	-0	-0	0	4	9.0090000E-02	2	-0.
33	18	26	-0	-0	0	4	6.3520000E-02	2	-0.
34	26	33	-0	-0	0	4	4.3410000E-02	2	-0.
35	33	39	-0	-0	0	4	7.0710000E-02	2	-0.
36	39	44	-0	-0	0	4	7.9120000E-02	2	-0.
37	44	49	-0	-0	0	4	8.0440000E-02	2	-0.
38	49	51	-0	-0	0	4	2.7420000E-02	2	-0.
39	51	54	-0	-0	0	4	4.1050000E-02	2	-0.
40	54	56	-0	-0	0	4	3.3020000E-02	2	-0.
41	56	58	-0	-0	0	4	3.1500000E-02	2	-0.
42	58	61	-0	-0	0	4	1.8600000E-02	2	-0.
43	61	63	-0	-0	0	4	1.9450000E-02	2	-0.
44	5	13	-0	-0	0	4	4.1840000E-02	2	-0.
45	13	22	-0	-0	0	4	3.5130000E-02	2	-0.
46	22	30	-0	-0	0	4	8.3120000E-02	2	-0.
47	30	37	-0	-0	0	4	9.1110000E-02	2	-0.
48	37	43	-0	-0	0	4	7.0310000E-02	2	-0.
49	43	48	-0	-0	0	4	4.6680000E-02	2	-0.
50	48	53	-0	-0	0	4	4.9660000E-02	2	-0.
51	53	57	-0	-0	0	4	4.1540000E-02	2	-0.
52	57	60	-0	-0	0	4	3.9780000E-02	2	-0.
53	24	23	-0	-0	0	4	2.6490000E-02	2	-0.
54	15	23	-0	-0	0	4	9.9230000E-02	2	-0.
55	39	38	-0	-0	0	4	1.5100000E-02	2	-0.
56	32	38	-0	-0	0	4	7.4420000E-02	2	-0.
57	54	50	-0	-0	0	4	1.2400000E-02	2	-0.
58	50	47	-0	-0	0	4	1.9930000E-02	2	-0.
59	51	46	-0	-0	0	4	1.2400000E-02	2	-0.
60	49	45	-0	-0	0	4	4.9050000E-02	2	-0.
61	52	50	-0	-0	0	4	4.6350000E-02	2	-0.
62	50	46	-0	-0	0	4	5.3270000E-02	2	-0.
63	7	15	-0	-0	0	4	1.1784000E-01	2	-0.
64	13	12	-0	-0	0	4	1.2400000E-02	2	-0.
65	12	11	-0	-0	0	4	1.4630000E-02	2	-0.
66	11	10	-0	-0	0	4	3.2190000E-02	2	-0.
67	10	9	-0	-0	0	4	3.0400000E-02	2	-0.
68	4	12	-0	-0	0	4	1.0995000E-01	2	-0.
69	12	21	-0	-0	0	4	7.9800000E-02	2	-0.
70	3	11	-0	-0	0	4	1.1903000E-01	2	-0.
71	11	20	-0	-0	0	4	6.6340000E-02	2	-0.
72	2	10	-0	-0	0	4	8.0030000E-02	2	-0.
73	10	19	-0	-0	0	4	4.9610000E-02	2	-0.
74	26	25	-0	-0	0	4	5.3580000E-02	2	-0.
75	25	24	-0	-0	0	4	4.1010000E-02	2	-0.

76	17	25	-0	-0	0	4	1.0109000E-01	2	-0.
77	25	32	-0	-0	0	4	7.4420000E-02	2	-0.
78	30	29	-0	-0	0	4	1.2400000E-02	2	-0.
79	29	28	-0	-0	0	4	4.7300000E-02	2	-0.
80	28	27	-0	-0	0	4	6.9940000E-02	2	-0.
81	27	26	-0	-0	0	4	9.4750000E-02	2	-0.
82	21	29	-0	-0	0	4	1.0803000E-01	2	-0.
83	29	36	-0	-0	0	4	4.9610000E-02	2	-0.
84	20	28	-0	-0	0	4	8.5310000E-02	2	-0.
85	28	35	-0	-0	0	4	4.9610000E-02	2	-0.
86	19	27	-0	-0	0	4	6.1900000E-02	2	-0.
87	27	34	-0	-0	0	4	4.9610000E-02	2	-0.
88	43	42	-0	-0	0	4	1.9030000E-02	2	-0.
89	42	41	-0	-0	0	4	1.7940000E-02	2	-0.
90	41	40	-0	-0	0	4	1.2400000E-02	2	-0.
91	40	39	-0	-0	0	4	1.2400000E-02	2	-0.
92	36	42	-0	-0	0	4	5.4130000E-02	2	-0.
93	42	47	-0	-0	0	4	6.4830000E-02	2	-0.
94	35	41	-0	-0	0	4	4.9610000E-02	2	-0.
95	41	46	-0	-0	0	4	4.9650000E-02	2	-0.
96	34	40	-0	-0	0	4	4.9610000E-02	2	-0.
97	40	45	-0	-0	0	4	4.9610000E-02	2	-0.
98	53	55	-0	-0	0	4	1.2400000E-02	2	-0.
99	55	58	-0	-0	0	4	1.2400000E-02	2	-0.
100	57	59	-0	-0	0	4	1.6300000E-02	2	-0.
101	59	61	-0	-0	0	4	1.9390000E-02	2	-0.
102	52	55	-0	-0	0	4	7.7850000E-02	2	-0.
103	55	59	-0	-0	0	4	7.7740000E-02	2	-0.
104	59	62	-0	-0	0	4	4.9630000E-02	2	-0.
105	16	15	23	-0	2	2	3.0000000E-02	1	-0.
106	23	24	16	-0	2	2	3.3590000E-02	1	-0.
107	15	14	23	-0	2	2	3.0000000E-02	1	-0.
108	24	23	31	-0	2	2	2.4421000E-01	1	-0.
109	33	32	38	-0	0	2	6.1470000E-02	1	-0.
110	38	39	33	-0	0	2	2.0445000E-01	1	-0.
111	32	31	38	-0	0	2	4.8280000E-02	1	-0.
112	39	38	44	-0	0	2	9.7270000E-02	1	-0.
113	56	52	50	-0	0	2	2.6158000E-01	1	-0.
114	50	54	56	-0	0	2	3.0000000E-02	1	-0.
115	52	48	47	-0	0	2	2.7276000E-01	1	-0.
116	47	50	52	-0	0	2	3.3245000E-01	1	-0.
117	54	50	46	-0	0	2	2.4267000E-01	1	-0.
118	46	51	54	-0	0	2	4.0460000E-02	1	-0.
119	50	47	46	-0	0	2	3.1092000E-01	1	-0.
120	51	46	45	-0	0	2	1.1111000E-01	1	-0.
121	45	49	51	-0	0	2	3.0000000E-02	1	-0.
122	49	45	44	-0	0	2	7.6350000E-02	1	-0.
123	8	7	15	-0	1	2	3.0000000E-02	1	-0.
124	15	16	8	-0	1	2	4.2590000E-02	1	-0.
125	7	6	14	-0	1	2	8.7540000E-02	1	-0.
126	14	15	7	-0	1	2	3.0000000E-02	1	-0.
127	5	4	12	-0	0	2	1.4600000E+01	1	-0.
128	12	13	5	-0	0	2	1.4600000E+01	1	-0.
129	4	3	11	-0	0	2	8.0000000E+00	1	-0.
130	11	12	4	-0	0	2	8.0000000E+00	1	-0.
131	3	2	10	-0	0	2	6.0000000E+00	1	-0.
132	10	11	3	-0	0	2	6.0000000E+00	1	-0.
133	2	1	9	-0	0	2	4.7500000E+00	1	-0.
134	9	10	2	-0	0	2	4.7500000E+00	1	-0.
135	13	12	21	-0	0	2	1.2782000E-01	1	-0.
136	21	22	13	-0	0	2	1.1927000E-01	1	-0.
137	12	11	20	-0	0	2	1.3184000E-01	1	-0.
138	20	21	12	-0	0	2	2.0672000E-01	1	-0.
139	11	10	19	-0	0	2	7.7650000E-02	1	-0.
140	19	20	11	-0	0	2	1.9455000E-01	1	-0.
141	10	9	18	-0	0	2	1.2447000E-01	1	-0.
142	18	19	10	-0	0	2	3.0507000E-01	1	-0.
143	18	17	25	-0	2	2	3.2570000E-02	1	-0.
144	25	26	18	-0	2	2	6.3580000E-02	1	-0.
145	17	16	24	-0	2	2	4.7320000E-02	1	-0.
146	24	25	17	-0	2	2	3.0000000E-02	1	-0.
147	26	25	32	-0	2	2	5.9520000E-02	1	-0.
148	32	33	26	-0	2	2	1.4888000E-01	1	-0.
149	25	24	31	-0	2	2	3.0000000E-02	1	-0.
150	31	32	25	-0	2	2	7.1740000E-02	1	-0.
151	22	21	29	-0	2	2	1.8478000E-01	1	-0.
152	29	30	22	-0	2	2	8.7543900E-02	1	-0.
153	21	20	28	-0	2	2	2.0682000E-01	1	-0.

154	28	29	21	-0	2	2	1.6272000E-01	1	-0.
155	20	19	27	-0	2	2	2.1676000E-01	1	-0.
156	27	28	20	-0	2	2	1.8898000E-01	1	-0.
157	19	18	26	-0	2	2	6.8210000E-02	1	-0.
158	26	27	19	-0	2	2	1.9179000E-01	1	-0.
159	30	29	36	-0	2	2	2.0997000E-01	1	-0.
160	36	37	30	-0	2	2	1.1609000E-01	1	-0.
161	29	28	35	-0	2	2	2.4674000E-01	1	-0.
162	35	36	29	-0	2	2	2.0689000E-01	1	-0.
163	28	27	34	-0	2	2	1.9576000E-01	1	-0.
164	34	35	28	-0	2	2	2.7859000E-01	1	-0.
165	27	26	33	-0	2	2	1.4457000E-01	1	-0.
166	33	34	27	-0	2	2	2.5042000E-01	1	-0.
167	37	36	42	-0	0	2	3.1900000E-01	1	-0.
168	42	43	37	-0	0	2	1.2494000E-01	1	-0.
169	36	35	41	-0	0	2	3.7497000E-01	1	-0.
170	41	42	36	-0	0	2	2.4048000E-01	1	-0.
171	35	34	40	-0	0	2	3.0143000E-01	1	-0.
172	40	41	35	-0	0	2	2.6486000E-01	1	-0.
173	34	33	39	-0	0	2	1.9680000E-01	1	-0.
174	39	40	34	-0	0	2	2.3962000E-01	1	-0.
175	43	42	47	-0	0	2	3.2677000E-01	1	-0.
176	47	48	43	-0	0	2	1.1183000E-01	1	-0.
177	42	41	46	-0	0	2	3.2038000E-01	1	-0.
178	46	47	42	-0	0	2	2.9956000E-01	1	-0.
179	41	40	45	-0	0	2	1.8953000E-01	1	-0.
180	45	46	41	-0	0	2	3.4280000E-01	1	-0.
181	40	39	44	-0	0	2	7.4450000E-02	1	-0.
182	44	45	40	-0	0	2	2.2986000E-01	1	-0.
183	48	52	55	-0	0	2	2.5936000E-01	1	-0.
184	55	53	48	-0	0	2	1.4464000E-01	1	-0.
185	52	56	58	-0	0	2	4.5110000E-02	1	-0.
186	58	55	52	-0	0	2	1.6257000E-01	1	-0.
187	53	55	59	-0	0	2	1.5237000E-01	1	-0.
188	59	57	53	-0	0	2	1.2689000E-01	1	-0.
189	55	58	61	-0	0	2	3.0000000E-02	1	-0.
190	61	59	55	-0	0	2	1.2135000E-01	1	-0.
191	57	59	62	-0	0	2	3.9010000E-02	1	-0.
192	62	60	57	-0	0	2	5.3390000E-02	1	-0.
193	59	61	63	-0	0	2	8.3927200E-02	1	-0.
194	63	62	59	-0	0	2	3.0000000E-02	1	-0.
195	67	68	64	-0	0	2	1.8100000E+00	1	-0.
196	64	68	65	-0	0	2	1.8100000E+00	1	-0.
197	68	69	65	-0	0	2	2.6000000E+00	1	-0.
198	65	69	66	-0	0	2	2.6000000E+00	1	-0.
199	69	1	66	-0	0	2	3.6000000E+00	1	-0.
200	66	1	9	-0	0	2	3.6000000E+00	1	-0.
201	64	67	-0	-0	0	4	1.0000000E+00	1	-0.
202	65	68	-0	-0	0	4	1.0000000E+00	1	-0.
203	66	69	-0	-0	0	4	1.0000000E+00	1	-0.
204	67	68	-0	-0	0	4	1.0000000E+00	1	-0.
205	68	69	-0	-0	0	4	1.0000000E+00	1	-0.
206	69	1	-0	-0	0	4	1.0000000E+00	1	-0.
207	1	2	-0	-0	0	4	1.0000000E+00	1	-0.
208	2	3	-0	-0	0	4	1.0000000E+00	1	-0.
209	3	4	-0	-0	0	4	1.0000000E+00	1	-0.
210	4	5	-0	-0	0	4	1.0000000E+00	1	-0.
211	64	65	-0	-0	0	4	1.0000000E+00	1	-0.
212	65	66	-0	-0	0	4	1.0000000E+00	1	-0.
213	66	9	-0	-0	0	4	1.0000000E+00	1	-0.
214	64	6	-0	-0	0	1	1.0000000E+00	1	-0.
215	65	7	-0	-0	0	1	1.0000000E+00	1	-0.
216	66	8	-0	-0	0	1	1.0000000E+00	1	-0.
217	6	7	-0	-0	0	4	1.0000000E+00	1	-0.
218	7	8	-0	-0	0	4	1.0000000E+00	1	-0.

AERO MESH DATA

STATION	NODES						
0.0000	1	2	3	4	5		
.2390	14	15	16	17	18	20	21	22
.3930	23	24	25	26	27	28	29	30
.5480	31	32	33	34	35	36	37	
.6480	38	39	40	41	42	43		
.7480	44	45	46	47	48			
.8560	56	55	57					

COLLOCATION STATIONS 2 3 4 5 6 7

FREE MODE 1 IS A PLUNGING MODE

1	1.000000000E+00	2	1.0000000C0E+00	3	1.000000000E+00
4	1.000000000E+00	5	1.0000000C0E+00	6	1.000000000E+00
7	1.000000000E+00	8	1.0000000C0E+00	9	1.000000000E+00
10	1.000000000E+00	11	1.0000000C0E+00	12	1.000000000E+00
13	1.000000000E+00	14	1.0000000C0E+00	15	1.000000000E+00
16	1.000000000E+00	17	1.0000000C0E+00	18	1.000000000E+00
19	1.000000000E+00	20	1.0000000C0E+00	21	1.000000000E+00
22	1.000000000E+00	23	1.0000000C0E+00	24	1.000000000E+00
25	1.000000000E+00	26	1.000C000C0E+00	27	1.000000000E+00
28	1.000000000E+00	29	1.0000000C0E+00	30	1.000000000E+00
31	1.000000000E+00	32	1.000C00000E+00	33	1.000000000E+00
34	1.000000000E+00	35	1.0000000C0E+00	36	1.000000000E+00
37	1.000000000E+00	38	1.0000000C0E+00	39	1.C00000000E+00
40	1.000000000E+00	41	1.0000000CCE+00	42	1.000000000E+00
43	1.000000000E+00	44	1.0000000C0E+00	45	1.000000000E+00
46	1.000000000E+00	47	1.000C000C0E+00	48	1.C00000000E+00
49	1.000000000E+00	50	1.000C000C0E+00	51	1.000000000E+00
52	1.000000000E+00	53	1.0000000C0E+00	54	1.000000000E+00
55	1.000000000E+00	56	1.0000000C0E+00	57	1.000000000E+00
58	1.000000000E+00	59	1.000C000C0E+00	60	1.000000000E+00
61	1.000000000E+00	62	1.000C000C0E+00	63	1.000000000E+00
64	1.000000000E+00	65	1.0000000C0E+00	66	1.000000000E+00
67	1.000000000E+00	68	1.000000000E+00	69	1.000000000E+00

FREE MODE 2 IS A PITCHING MODE

1	2.160000000E+03	2	2.2475000C0E+03	3	2.335000000E+03
4	2.422500000E+03	5	2.5100000C0E+03	6	1.390000000E+03
7	1.655000000E+03	8	1.9200000C0E+03	9	2.160000000E+03
10	2.247500000E+03	11	2.3350000C0E+03	12	2.422500000E+03
13	2.510000000E+03	14	1.390000000E+03	15	1.655000000E+03
16	1.920000000E+03	17	2.0400000C0E+03	18	2.160000000E+03
19	2.247500000E+03	20	2.335C000C0E+03	21	2.422500000E+03
22	2.510000000E+03	23	1.7400000C0E+03	24	2.005000000E+03
25	2.125000000E+03	26	2.245C000C0E+03	27	2.320000000E+03
28	2.395000000E+03	29	2.47C0000C0E+03	30	2.545000000E+03
31	2.090000000E+03	32	2.210C000C0E+03	33	2.330000000E+03
34	2.392500000E+03	35	2.4550000C0E+03	36	2.517500000E+03
37	2.580000000E+03	38	2.2950000C0E+03	39	2.415000000E+03
40	2.477500000E+03	41	2.5400000C0E+03	42	2.602500000E+03
43	2.665000000E+03	44	2.500C000C0E+03	45	2.562500000E+03
46	2.625000000E+03	47	2.6875000C0E+03	48	2.750000000E+03
49	2.547500000E+03	50	2.6725000C0E+03	51	2.595000000E+03
52	2.720000000E+03	53	2.8033000C0E+03	54	2.642500000E+03
55	2.778300000E+03	56	2.6900000C0E+03	57	2.856650000E+03
58	2.753300000E+03	59	2.8367000C0E+03	60	2.910000000E+03
61	2.816650000E+03	62	2.895C000C0E+03	63	2.880000000E+03
64	1.390000000E+03	65	1.655C000C0E+03	66	1.920000000E+03
67	1.390000000E+03	68	1.6550000C0E+03	69	1.920000000E+03

```
DESIGN CONSTRAINTS CONSIDERED
    FLUTTER - T
     STRESS - F
    MINGAGE - T


INPUT DATA FOR SEARCH ROUTINE

    NUMBER OF DESIGN VARIABLES....NC =  2
                                   R =  1.25000000E-01
    R REDUCTION FACTOR...........RDC =  2.00000000E+01

TUL( 1)= 1.00000E+01
TUL( 2)= 3.00000E+01
TUL( 3)= 1.00000E-02
```

NO.	POINTS OR ELEMENTS	VALUE	MASS DERIVATIVE
1	SEGMENT 1 POINT 1	1.20000000E-01	1.90366125E+02
	SEGMENT 1 POINT 2		
	SEGMENT 1 POINT 3		
	SEGMENT 1 POINT 4		
	SEGMENT 2 POINT 1		
	SEGMENT 2 POINT 2		
	SEGMENT 2 POINT 3		
	SEGMENT 2 POINT 4		
2	ELEMENT127	1.20000000E-01	4.95425000E+01
	ELEMENT128		
	ELEMENT129		
	ELEMENT130		
	ELEMENT131		
	ELEMENT132		
	ELEMENT133		
	ELEMENT134		
	ELEMENT135		
	ELEMENT136		
	ELEMENT137		
	ELEMENT138		
	ELEMENT139		
	ELEMENT140		
	ELEMENT141		
	ELEMENT142		

```
TOTAL NUMBER OF D.O.F. =207
THIS PROGRAM REQUIRES 050014(OCTAL) OF BLANK COMMON




THIS PROGRAM REQUIRES 064463(OCTAL) OF BLANK COMMON
```

FLUTTER CONDITION NO. 1

OMEGA RADIANS/SEC.	H	DETERMINANT REAL PART	IMAGINARY PART
0.	-2.13360000E+03	-3.09988563E-01	6.08905400E-14
0.	-2.13360000E+03	-3.09988563E-01	6.08905400E-14
0.	-9.06600374E+02	-9.44458242E-02	2.55314798E-14
0.	-9.06600374E+02	-9.44458242E-02	2.55314798E-14
0.	2.02326799E+01	-2.61201487E-02	1.28207475E-14
0.	2.02326799E+01	-2.61201487E-02	1.28207475E-14
0.	5.79142528E+02	-5.45192913E-03	8.35960388E-15
0.	5.79142528E+02	-5.45192913E-03	8.35960388E-15
0.	7.78376291E+02	-5.04705011E-04	7.16444296E-15
0.	7.78376291E+02	-5.04705011E-04	7.16444296E-15
0.	8.01101672E+02	-6.01386399E-06	7.03910442E-15
0.	8.01101672E+02	-6.01386399E-06	7.03910442E-15
0.	8.01379193E+02	-2.08923682E-09	7.03758698E-15
0.	8.01379193E+02	-2.08923682E-09	7.03758698E-15
0.	8.01379290E+02	-1.41200545E-11	7.03758646E-15

COMPLEX DETERMINANT CONVERGED TO 0
G(1) = 2.78917983E-02
G(2) = 1.00000000E+00
G(3) = 1.20000000E-01

VARIABLE MASS = WT = 2.87890350E+01
TOTAL STRUCTURAL MASS = TWT = 4.49103812E+02
PF = PENALTY FUNCTION = 4.85764585E+01
PFUNC = WT + PF = 7.73654935E+01

DESIGN VARIABLES 1- 2
1.20000000E-01 1.20000000E-01

QUADRATIC CONVERGENCE TEST SATISFIED

QUADRATIC CONVERGENCE TEST SATISFIED
****

THE FOLLOWING INFORMATION IS FOR THE FINAL DESIGN

CTEST = 1.02221981E-02

ESTIMATED MINIMUM MASS LESS THAN TWO PERCENT LOWER THAN PRESENT MASS
DESIGN CONSIDERED CONVERGED

FINAL MASSES
WT = 1.47646896E+01 TWT = 4.35079466E+02

FINAL CONSTANTS
7.75505268E-02 3.42396727E-05

FLUTTER CONDITION NO. 1

OMEGA RADIANS/SEC.	H	DETERMINANT REAL PART	IMAGINARY PART
0.	1.49696471E+03	-5.18838412E-10	4.78596657E-15
0.	1.49696471E+03	-5.18838412E-10	4.78596657E-15
0.	1.49696476E+03	-2.19868265E-12	4.78596640E-15

COMPLEX DETERMINANT CONVERGED TO 0
G(1) = 1.04350932E-03
G(2) = 1.00000000E+00
G(3) = 6.84491241E-05

REFERENCES

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